Clinging to discredited beliefs: the larger cognitive story

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Abstract: A large body of research demonstrates the incredible power of initial conceptions, scripts, and stereotypes that result from our naïve theories. Prior knowledge compatible with information introduced by instructors enhances encoding and retrieval, but hinders learning when in conflict with it. Theories and facts contradicting existing beliefs are conveniently misinterpreted, treated as insignificant, or taken as valid only within the confines of classrooms. Belief perseverance—clinging to explicitly discredited beliefs—is ubiquitous to the point of serving as the ultimate evidence of the feebleness of our mind. Standard explanations in terms of supporting beliefs and affective-motivational components are partial at best. This paper proposes an explanatory model that illuminates the cognitive-adaptive sources of perseverance, demonstrating its inevitability given the general principles of economy and equilibrium that govern brain operations, the naïve theories we generate to make sense of the world, and the heuristics we employ to meet adaptive goals.

Keywords: belief-perseverance, learner's cognition, pet theories, active learning

I. What is Belief Perseverance?

Belief Perseverance labels the phenomenon of maintaining beliefs and theories against explicit conflicting evidence. Examples are abandoned in everyday life, science, and in experimental settings. Festinger (1956) tells about a small religious group's leader who predicted the destruction of the world by flood on a specific day, while only the faithful will be saved by a spaceman. In preparation for the trip, people quit their jobs and discarded valuable possessions. The flood did not take place on the designed day, but group members became more devoted to their leaders.

The theory of *Spontaneous Generation* provides a notorious example of belief-perseverance. Promoted by Aristotle, the theory that states that living things can arise from non-living material was maintained for 2000 years, supported by common observations (e.g., worm-like maggots appear on meat left out too long). Van Helmont, a well-known Belgian doctor, wrote in 1600 a recipe for making mice by throwing grains and old rags into a room corner. In 1660 the Italian doctor Redi challenged the theory by leaving meat in open and in closed containers, and getting maggots only in the open ones. His conclusion—that maggots appear from eggs laid on the meat—was rejected on the additional assumption that air must be allowed to circulate freely in the closed jars for life to develop, since air carries some unknown "active principle" necessary for spontaneous generation to occur. An experiment that involved boiling the meat, thereby excluding the appearance of maggots, was rejected on the argument that "boiling destroys the active principle". Redi then proceeded to cover the jars with a fine mesh cloth that allowed air to flow (but not eggs to be laid). The thesis of spontaneous generation gained popularity with the discovery of microorganisms, that are "made from food and water", and was not rejected by science for a century after Redi's

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death. The "emotional long-term investment of scientists" cannot by itself account for the radical moves designed to maintain the theory against all evidence to the contrary. The following example illustrates that a long-term "incubation" of a belief is not necessary for its perseverance.

Ross (1975) presented three groups of people with the task of discerning authentic *suicide notes* from inauthentic ones. Group A was given highly positive feedback, group B was told that their performance was close to average, and group C received a low evaluation. Upon completing the task, all subjects were told that the evaluations did not correspond to their performance but were manipulated beforehand as part of the experiment. They were all shown the experimenter's written instructions that specified the feedback to be given to each arbitrarily selected group. The subjects were then asked to evaluate, in a post-experimental questionnaire, their performance on the task as well as to rate their ability in suicide-note discrimination cases. Perseverance was quick to raise its ugly head: those who were pre-assigned to success reported evaluations far higher than the others, and the opposite evaluation was self-assigned by the "failing" subjects.

What tricks do we employ in order to maintain exposed false beliefs?

The standard devices we use normally "abuse" the incoming discrediting information: we treat it with deliberate misinterpretation that renders it either irrelevant to the belief in question or even as confirming evidence; or we assign low weight to it, ignore it completely, or confine its validity to a convenient "paradigm".

The Usual Suspects: Prevailing "folk-psychological" explanations for belief perseverance range from misunderstanding, ignorance, embarrassment of admitting being wrong, cognitive "laziness", stubbornness, or emotional considerations, all the way to stupidity and sheer irrationality. The phenomena of belief perseverance are so ubiquitous, that it is often used as the ultimate evidence of the feebleness of our minds, the illogical aspect of human thought, and the futility of formal education. It is commonly considered a temporary mental disorder in the processes of belief acquisition and maintenance, and thus can and should be removed at any price.

More promising attempts link the phenomenon with "confirmation biasing processes" of evidence stored in the memory (Nisbett & Ross, 1980), or with "hypothesis-confirming" retrieval mechanisms (Snyder & Cantor, 1979). Lepper (1986) mentions the "Fundamental Attribution Bias" as a contributing causal component, and hints that the selective and constructive nature of our memory may be at fault, but mostly puts the explanatory burden on the formation of supportive causal scenarios: "People spontaneously generate explanations for events as a way of understanding events, including their own beliefs. If an explanation is generated, this explanation becomes a reason for holding an explained belief, even if the belief is eventually undercut by new evidence" (Shultz, 2001). Fleming (1979) demonstrated the reduction of belief perseverance in subjects that were not given an opportunity to generate causal explanation. The demonstration indicates that belief perseverance has deeper roots than what folk psychology alludes to, but it only shifts the burden to accounting for the perseverance of the causal explanation. These hypotheses leave the most interesting questions unanswered: (i) How can the belief persevered be acquired if all its supporting explanations are produced in retrospect? (ii) Why would the explanations have cognitive salience that accounts for their sustainability? (iii) What are the cognitive mechanisms responsible for the acquisition and maintenance of the type of beliefs persevered? (iv) What can we do about them?

Belief Perseverance is a convenient label for a complex phenomenon, whose long-term expository investigation by experimental psychologists yielded explanations that fail to

couch the phenomena within larger rubrics of cognitive operations, or lead to effective remedies. Instead of dismissing belief perseverance as a peculiarity of the illogical mind, or shifting the burden of perseverance to other beliefs, this paper attempts move from what Ramachandran calls the "phenomenon-driven stage" to the "theory-driven stage" by understanding the sources and the adaptive value of belief perseverance and ways of combating this tendency that are compatible with the workings of our brains.

II. The Big Picture.

Question: "What forces act on a coin that has been tossed straight up in the air?" The correct answer: only the force of gravitational pull toward the earth acts on the coin, once it is airborne. Alas, 70% of college students who had completed a course in mechanics in MIT gave the same answer as students who had not been exposed to any mechanics or physics training: they cited two forces, the downward force of gravity and "the original upward force of the hand". Most people also believe that the change in seasons is a direct function of the distance of the earth from the sun, that the process of evolution brings species gradually to the ideal of perfection, and that economically good times are associated with low interest rates. These beliefs are part of our "pet theories" – cognitive construct that are inevitable by-products of growing up, and are amazingly resistant to change under the influence of formal education (see Figure 1).

Dispositions	Adaptive Goals	Outcomes
Coherence	Control	
Causality	Efficient processing	
Dissonance resolution	Ego defense	
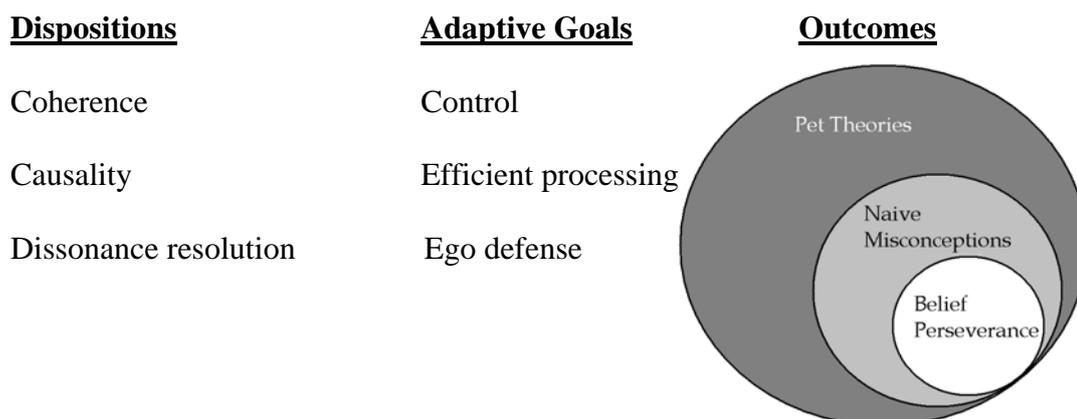
Figure 1. Dispositions, Adaptive Goals, and Outcomes.

Our minds are not "blank slates"—they are densely populated with incredibly powerful initial conceptions, naive views, scripts, and stereotypes that we form from experience in order to make sense of the world. We are driven by *dispositions* necessary for survival: finding causal relations between events, generating a coherent picture of the world (with generalizations, analogies, stereotypes, and convenient "gap-filling" hypotheses), and most notably—eliminating cognitive and emotive dissonance (with belief confirmations and ego defense mechanisms). These dispositions aim at meeting our *adaptive goals*, among them increasing control over the environment by enabling correct predictions of events, processing huge amounts of information rapidly with the least amount of cognitive investment, and protect our fragile ego from injury. Because we are predisposed to find coherence, meaningfulness, and order, we end up imposing theories on inherently random phenomena and build complicated schemas. The interaction of our dispositions with innate skills and experience generate one of the most robust tools we have for meeting our adaptive needs: pet theories. The term "theory" generally refers to a consistent set of interrelated propositions that have an explanatory power for a certain physical, social, philosophical, or mental

phenomenon, and lead to predictions commonly supported by experiments. Pet theories rest on personal experience, not by controlled experiments; but just like scientific theories they have explanatory and predictive functions.

Why do we construct pet theories?

We develop intuitive theories involuntarily from a very early age as part of our *evolutionary survival kit* in an attempt to establish better control over our environment, produce causal connections and coherence in our experiences, and draw analogical inferences and generalizations from them. The process of acquiring knowledge starts, at the latest, soon after birth. Infants show amazing ability to distinguish among forms, faces, and visual and auditory patterns; to discern focal from marginal colors; and to pair up an object they have seen with one they touch. A three-week old baby can associate a loud sound with bright colors; a three-and-a-half-month-old realizes that objects continue to exist after they move out of sight, and that two objects cannot occupy the same space; at six months babies distinguish groups of two from groups of three objects; and at one year children show understanding of some principles of causality.

During the first years of life children master a large host of competencies without instruction: they manage to recognize and keep track of many faces and objects, they learn to talk, sing, dance, joke, play ball, and manipulate toys, machines, and people; they become experts in deceiving and tricking others, and they notably develop a sense of fairness, truth, good, and evil. Along with these visible skills, children "invent" and develop complicated hypotheses about causal relations between physical and mental events, and about the nature of the external world, other minds, free will, moral judgments, the boundaries of knowledge, the "good life", rights and obligations, and "normal behavior". They also engage in intricate social relations with family members, friends, authority figures, and strangers. Without any formal training or even a source to imitate, children construct possible states of affairs in which they change facts, develop them, confirm or deny them, invent social situations, and make alterations to fit their naive conception. These early capacities and bits of knowledge accumulated from the surface features of experiences and meager inferential tools form the foundations for hypotheses about colors, sounds, quantities, and symbols, and about basic properties of physical objects, self, other minds, etc -- which in turn develop into pet theories.

Pet theories are the inevitable consequent of the ways information is presented to our senses, our disposition and biological need for ordering and controlling the phenomena of living, and the flaws in our information processing, intuitive assessments, and inference abilities that often illustrate the speed-accuracy tradeoff. They are based on surface features of the relevant concepts, rely on principles that emerge spontaneously, derived from everyday experience, commonsense, and intuitive generalizations, they are fragmented and often inconsistent, but seemingly well organized. Most are continually revised with use and with intellectual maturity, but they are not normally tested (voluntarily) against scientific theories or social facts, nor are they subjected to metacognitive tests, such as the attempt to detect inconsistencies, or to generate some closure of the relevant beliefs by drawing all their immediate or even just trivial consequences. These theories are complex, intricate, serviceable, useful, and partly correct, and in spite of their logical shortcomings, biases, and prejudices, they provide useful general frameworks for comprehending events, and for planning and encountering new facts or theories.

Pet theories have *naïve misconceptions* as the price tag for their pragmatic efficiency. These misconceptions often contain beliefs that are extremely resistant to change, and tend to emerge when the well-trained person attempts to apply formal instruction principles. *Belief*

perseverance takes place when certain naïve misconceptions are maintained in spite of full awareness of their falsity.

III. Partial Taxonomy of Perseverance.

Table 1. Types of Beliefs Persevered.

The content range of beliefs that can be persevered

Content Type	Examples
General/Theoretical	Change of seasons is determined by proximity to the Sun
Particular/Pragmatic	Dietary supplements are essential for health
Social/Personal	Attribution fallacy

The range of contents of beliefs persevered is surprisingly wide (see Table 1). Some are highly abstract; others are theoretical with practical applications, such as "magical beliefs" and superstitions. Some beliefs relate directly to self-conception, e.g., the amusing and resilient "above average" belief we are better than the average person in positive traits (humor, intelligence, driving, or health), and below average in negative traits (being prone to biases). We persevere in believing that we control random events (the gambler's fallacy), and that our tendencies and opinions are very prevalent among our peers ("false consensus"). Other persevered beliefs relate to social issues, such as social Darwinism, racist beliefs, stereotypes, or cultist beliefs.

Table 2: Ways of Discrediting a Belief (B).

	Ways of Discrediting B	Examples
D1	Additional information dilutes the truth of B	Iraq's possession of WMD in 2002
D2	B is exposed as a conclusion of a fallacious argument	Stereotypes, first impression, superstitions, racial discrimination
D3	Total evidentiary support for B is removed	Deluded self-assessment

D1. B is a relatively justified conclusion from certain premises, but additional information called for its removal (see Table 2). For instance, initial scarce evidence was sufficient to form the belief that Iraq has well-developed WMD in 2002, but later findings made this belief unjustified. A recent poll (Robertson, 2003), however, found that 34% of Americans surveyed still believe that these weapons were actually found in Iraq. Autism, to cite another sad example, was blamed on the mother's attitude as late as 20 years ago. Contrary to all neurological evidence, many still persevere in that belief. Intervention in the form of exposing the believer to the "belief confirmation" heuristic, the overconfidence bias, or to other universal cognitive mechanisms she employs may alter the severity of the perseverance by jumpstarting its re-evaluation in lieu of the new evidence.

D2. B is the conclusion of a fallacious inference, such as false analogy, hasty generalization, or misapplication of correct rules. Many notoriously persevered beliefs fall under this classification: racial stereotyping, first impressions, the deterrent effects of the death penalty, sunk costs, and magical beliefs. D2 stems mostly from naïve misconceptions

about correct inferences (e.g., "false analogy", "hasty generalization", "ad hominem"), so perseverance could be reduced with education in formal logic.

D3. The total evidentiary support for B is removed. For instance: self-assessment beliefs in the "suicide notes" experiment, "imaginary infants" (the belief that blackouts, climatic disasters and even athletic strikes create a baby-boom nine months later), and many "ego defense" and self-assessment beliefs. Induced self-perception of efficacy promotes higher accomplishments and lower emotional arousal of stress (Bandura 1982), and persists against disclosure, as do our beliefs that we are aware of our beliefs and motivations, that we know the reasons for our emotional states, and that we can predict accurately what will make us happy.

D1 weakens the veracity of B, while D2 exposes a faulty logical relationship between B and its evidence. D3, which eliminates the justification for acquiring the belief B to begin with, seems to be the most problematic, since there is no "root" left to "uproot" and no process to correct. It is usually acquired from minimal, tentative, ill-founded evidence, which should be the easiest to nullify once proven false. No immediate remedy is visible for this type of perseverance, being the most enigmatic irrational product of our system's prerogatives and so it calls for a deeper investigation of the cognitive forces behind it. Katz (1960) suggests that "the reasons for holding or for changing attitudes are found in the functions they perform for the individual, especially the functions of adjustment, ego defense, value expression, and knowledge". The thesis proposes for attitude-change can be applied to belief-revision. Understanding the cognitive and emotive drives behind this kind of belief perseverance may illuminate to road to potential treatments.

IV. The Cognitive Story.
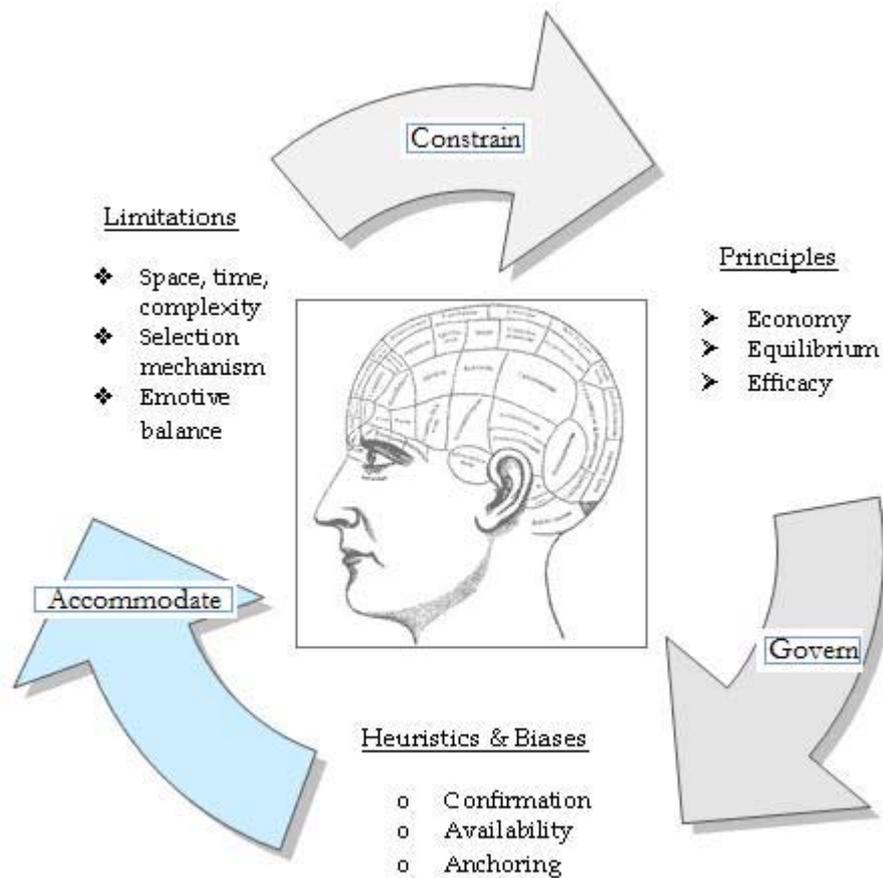
Figure 2. The Cognitive Story.

The world presents to us a messy array of incomplete, ambiguous, often unrepresentative data (see Figure 2). *Our Cognitive Machinery* displays amazing computational abilities, but is also limited by storage space, reaction time, by involuntary selection and search mechanisms, by inferential length and complexities, and by the need for continuous equilibrium to avoid stress. Our brain's operations are constrained by its limitations and by the adaptive goals of the organism. *Cognitive economy* leads to the tradeoff of accuracy for quantity of information and speed of processing. This tradeoff dictates the employment of information-processing heuristics that allow simplification and easy categorization. *Cognitive equilibrium* engages heuristics to fulfill dispositions such as coherence, control and understanding. It is part of a larger psychological immune system (Wilson, 2005) designed to reduce dissonance, balance resource management, maintain default positions, generate and sustain an ego.

Belief perseverance is supported by heuristics such as belief confirmation, anchoring, and availability, and by biases such as overconfidence. *Confirmation bias* names our fundamental tendency to seek and incorporate information that is consistent with our current beliefs and theories, while avoiding, not comprehending, or putting less weight on ideas that potentially disconfirm our naive conceptions. People tend to over-rely on instances that confirm their beliefs, and accept with ease suspicious information. Evidence that seems incompatible with the pet theory is either discounted as irrelevant, explained away, or critically scrutinized and minimized. The *Availability heuristic* illustrates our tendency to judges the relative number of instances or the probability of an event by the ease with which relevant instances are recalled or imagined. *Anchoring* causes us to sticking to the initial presentation in the process of comprehension or problem solving, to the point of abandoning additional presentations that may be relevant. *Overconfidence* in our understanding,

memories and judgments is often the result of insufficient insight into the economical and equilibrium-driven ways we construct pet theories, and ignorance of the constructive nature of our memory. Overconfidence implies not only inaccurate comprehension and retrieval, but also failure to recognize the need to improve.

V. Conclusions.

This paper proposes an explanatory model of belief-perseverance, which links basic cognitive adaptive needs with the tools we brings to bear on our survival tasks. These tools, cognitive heuristics, create pet theories that contain naïve misconceptions and false persistent beliefs that all contaminate all cognitive systems. The mind's governing principles cause inevitable trade-offs between quantities of information, speed of processing, accuracy, and dissonance-avoidance, resulting in a costly maintenance of faulty prior knowledge and inadequate long-term learning. Belief perseverance is anchored in adaptive principles and operations of the mind: it is an inevitable result of otherwise effective mechanisms, and its removal is not always beneficial to the system as a whole.

What happens when the naive meets the "sanctioned"?

Formal instruction in concepts, theories, and explanations often contradict the basic assumptions and predictions of our unscientific intuitive models. The result of presenting the new knowledge to the resisting old "knowledge" is usually manifested in one or more of the following:

- The new information is either discarded wholly or partially, usually deemed "incomprehensible" or totally irrelevant.
- The new information is altered so that it is given an interpretation that fits the pet theory; the mix of the old with the incompatible new is normally carried out in logically unscrutinizable ways.
- Some people reluctantly adapt the new theory as a "school bound explanation," while holding on to the incompatible familiar knowledge as reliable and relevant outside academia. The new formal knowledge is perceived as confined to what is required in school, but as not applicable in daily life.

How do we kill the beast?

The theoretical model outlined here offers directions for answers to the puzzles associated with perseverance: beliefs are acquired because they 'fit' with the relevant pet theory, and they persevere due to being well situated in the set of naïve misconceptions to the point of creating an economical or equilibrium havoc upon removal. "Many of the mechanisms that distort our judgments stem from basic cognitive processes that are usually quite helpful in accurately perceiving and understanding the world", writes Gilovich (1991, p. 10). Cognitive principles and their heuristic soldiers are responsible for our normal success in achieving daily tasks are also behind the resistance to change beliefs that are well incorporated into the web of beliefs, and whose removal may damage the system as a whole.

Understanding the sources and the necessary functions of pet theories and our cognitive principles are prerequisites for successful belief modification. This understanding can be enhanced by examining these forces in class as part of the course content, and by devising "student-centered" teaching strategies, which emphasizes process over product, and rest on the assumption that learning is by nature an active endeavor, as displayed by the

construction of pet theories and their constant (mostly unconscious) development. Student-centered instructional techniques satisfy our dispositions for control (over the learning process) and for coherence in our world-view. They tend to alleviate anxiety, enhance motivation, and promote the use of metcognitive skills of awareness, reflection, monitoring, and revising learning outcomes.

A teacher centered instructional style gives the student little opportunity to respond immediately to the instruction. The teacher proceeds upon assumptions about the students' prior knowledge, skill level, motivation, common vocabulary, and level of comprehension. Errors in these hunches often lead to faster or slower transmission of material than appropriate, to making the content too difficult or too easy, and to an engagement with the material as "school bound" content to be memorizes verbatim. The students become frustrated, apathetic, dependent, and unmotivated. Instructional devices, which sustain learning for understanding rather than for repetition and memorizing, prove crucial for significant learning outcomes.

The following proposes several student-centered instructional techniques:

- **Student's dialogue** with herself: reflect about the topic; keep a daily journal or develop a learning portfolio of what she studied, how, and its effect on her.
- **Dialogue with others** in intense small groups, clearly instructed.
- **Observe** or listen to others performing or solving a content problem.
- **Doing**: critique, investigate resources, give a presentation, role-play, develop a questionnaire, or compose a test.
- **Design** an experiment, conduct a band, propose research topics, or identify the principles of a good paper/presentation/task execution.
- **Think-pair-share**: the students reflect briefly on an issue, discussed it with a peer, they formulate a correct response and share with the class as part of a formal discussion.
- **Cooperative learning**: activities done in groups of three or more students, usually assigned complex tasks such as research projects or presentation.
- **Collaborative learning**: classroom strategies involving an equal collaboration of students and instructors, for instance designing tests or choosing reading materials.
- **One-minute paper**: a short written exercise or response to class material or teaching techniques, e.g., "what was the muddiest point in today's class?"
- **Response** to class material (on the board, paper, e-mail, chat room): "I'll remember from today's class that…", "I was surprise to learn today that…"
- **The Socratic method** utilizes questions to test comprehension and increase students' involvement: a chosen student is presented with a question, then another, till the full answer is provided (works best after a quiet wait time).
- **Summarize another student's answer** is a technique to promote active listening.
- **Brainstorming** takes place when the class as a whole is asked to make as many suggestions as possible as a response to a well-designed question.
- **The fish bowl** is where students deposit their (single) clarification or application question concerning class material, and the instructor or other students respond to them later.
- **Note comparing** and sharing can help students develop note-taking skills.
- **Concept mapping** in cooperative work demand identifying and organizing knowledge meaningfully by defining the connections between terms/concepts covered in class and integrating them systematically. The results are usually visual representations, such as flowcharts, models, diagrams, drawings, or networks of ideas.

- **Jigsaw group project** require each member to complete a discrete part of an assignment, rendering each a content-specific expert; upon completion the group reforms to put the pieces together.
- **Panel discussion** can be combined with a jigsaw group project: each member presents her findings, and is expected to respond to questions from the audience.
- **Debates** and **role-playing** are effective when the subject matter lends itself to clearly opposing views, and when the exercise is highly structured.
- **Case study** allows for an open-ended story as a vehicle for analysis, criticism, decision-making, and application.
- **Reciprocal peer questioning** requires students to prepare questions about the material, discuss with their study group, and select one question from each group for sharing with the class.
- **Spontaneous group dialogue** starts with (secretly) assigning distinct roles to a few students (discussion leader, opinion, seeker, disagreer, expert, fallacious thinker, skeptic), while the observers to the dialogue they actors produce have to identify the roles, biases and mistakes, levels of knowledge, understanding, and leadership; ethical conflicts, logical deviations, ambiguity in the material presented, the need for further research etc.
- **Student-led review sessions** works best when students are instructed to prepare and post questions, and are expected to volunteer to provide answers to some of the others' questions.
- **Class research symposium,** akin to professional meetings, can take place publically (with invited students and faculty) to demonstrate research projects generated by the whole class or several groups.
- **A newsletter** can be produced and written by students about specific topics related to class content; it may include published articles, student papers, or information about related public events.
- **Thought-provoking findings** can be posted by students and the instructor in the course forum site. The posting share interesting bits of information, discoveries, scientific and social news, and encourages responses.

The most robust devices for overcoming belief-perseverance can be called "*super active learning*" techniques (see Savion 2005 for details). They include, for instance, assignments that call the student to function (temporarily) as a teacher. Such assignment may involve in-class teaching of specific material to a group, pairing students from upper and lower class as "tutoring" units, or assign the teaching (and reporting) of a difficult concept to an outsider. The benefits of incorporating appropriate teaching techniques that render your student into a teacher include:

- Reduction of well-embedded misconceptions that normally inhibit the acquisition of the academically accepted theories and explanations.
- Familiarity with one's own learning styles and possibly the development of cognitive flexibility, such as moving from the serialistic style to the holistic style when coping with new material.
- Development of metacognitive skills, including awareness of one's approach to problem solving, monitoring of the process, and revising unsuccessful methods when necessary.
- Critical awareness of diverse (even wrong) approaches, which enriches one's understanding of complex material, and helps prevent future mistakes.
- Understanding of different levels of understanding, e.g., as demarcated by the abilities to summarize, criticize, analyze, synthesize etc.

- An appreciation of the distinction between knowing and being able to teach properly, and of the role of the instructor as facilitator of comprehension via active learning.

Teaching involves preparation, deep engagement with the material, awareness of oneself as a learner, realization of muddy spots and less intuitive constructs, thinking "on your feet", and having a well-developed theories of other minds. More often than not, these techniques help significantly in reducing the phenomenon of belief perseverance on the part of the provisional teacher. The awareness of the intuitive and adaptive value of our worst prejudices and persistent follies and their place in the larger cognitive picture of the mind's operations can have a robust effect on our self-understanding. We may be able then to establish effective intervention techniques to reconcile the academically sanctioned with the pre-existing beliefs by learning how to map the new concepts, ideas, and observations onto the network of the naive conceptions that produced perseverance, and how to overcome them in accordance with the ways our minds work.

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