What is learning and what does it look like when it doesn't go well?

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What is learning? Thirty-five years ago, I taught my first course as a college teacher at Michigan State University. It was a course on the psychology of learning. I can almost trace my career by saying that before I studied psychology, I had only the sketchiest understanding of what learning was. After I finished graduate school and first began teaching the psychology of learning, I was confident that I really understood what the process of learning entailed. However, over the past 35 years, I have systematically studied learning and understanding in many contexts, and I have taught many courses on the subject. Alas, my understanding has now become more complex, vague, and somewhat ambiguous.

When I began teaching learning theory, our conception of learning was fairly simple. For any given learning situation, the "inside" of the learner was treated as more or less empty; learning was understood as a process of getting the knowledge that was outside the learner--in books, theories, the mind of the teacher--to move inside. We tested for the success of learning by giving tests to look inside the heads of our students to see if what had previously been outside was now there. I exaggerate, but there was a comforting simplicity to our psychological behaviorism in those days.

We now understand that learning is a dual process in which, initially, the inside beliefs and understandings must come out, and only then can something outside get in. It is not that prior knowledge must be expelled to make room for its successors. Instead, these two processes--the inside-out and the outside-in movements of knowledge--alternate almost endlessly. To prompt learning, you've got to begin with the process of going from inside out. The first influence on new learning is not what teachers do pedagogically but the learning that's already inside the learner.

David Ausubel was one of the pioneering cognitive educational psychologists. He wrote a lovely epigraph at the beginning of his 1968 textbook, Educational Psychology: A Cognitive View: "If I had to reduce all of educational psychology to just one principle, I would say this: The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly."

We've come to understand more clearly the extent to which learners construct meaning out of their prior understanding. Any new learning must, in some fashion, connect with what learners already know. Of course, that is an oversimplification, but it is what I mean by "getting the inside out." As teachers, unless we can discover ways of getting the inside

out and looking jointly at their prior knowledge with our students, taking seriously what they already know and believe, instruction becomes very difficult. Our first principle, therefore, begins with the assertion that we must take seriously what the students have already learned. To take learning seriously, we need to take learners seriously.

An interesting surprise is that once what is inside gets out, it seldom just sits there; in a setting where serious activity and/or discussion is possible, that knowledge is enriched and elaborated by social interactions with people who have also experienced their own processes of getting what's inside out. Thus, learners construct their sense of the world by applying their old understandings to new experiences and ideas. That new learning is enriched enormously by the ways in which people wrestle with such ideas on the "outside," before they bring those ideas back inside and make them their own. This explains why one of the most important remedies for combating the illusion of understanding and the persistence of misconceptions is to support learners in the active, collaborative, reflective reexamination of ideas in a social context.

Learning is least useful when it is private and hidden; it is most powerful when it becomes public and communal. Learning flourishes when we take what we think we know and offer it as community property among fellow learners so that it can be tested, examined, challenged, and improved before we internalize it.

What Does it Look Like When Learning Doesn't Go Well?

I call this topic the "epidemiology of mislearning," or the "taxonomy of pedago-pathology." As I indicated earlier, there are three such pathologies: we forget, we don't understand that we misunderstand, and we are unable to use what we learned. I have dubbed these conditions *amnesia, fantasia, and inertia.*

Amnesia is one of the most frequent pathologies of learning--perhaps the most frequent. Students ordinarily and regularly forget what they have learned in their classes. Indeed, at times they forget that they even attended some classes.

More than 30 years ago, medical educators conducted a study on what first-year medical students remembered of the thousands of new terms that they'd memorized in their first-year gross anatomy course. They were tested and retested over time. The curve that matched most closely to their forgetting of gross anatomy was the same shape as discovered in Hermann Ebbinghaus's classic study of memory for nonsense syllables a century ago. The publication of data like these made a mark in the world of medical education. The teaching of anatomy has since changed radically in schools of medicine.

My colleagues and I at Stanford conducted a study in which we asked graduate students who were preparing to become high school teachers to bring their undergraduate college transcripts to an interview. We were trying to understand the connections between what and how they had learned in college, and the ways they themselves would teach in high school. We asked them to walk us through their college transcript course by course, and tell us what they remembered about each course. Certainly, they remembered the contents, teachers, and the activities of many courses vividly. On the other hand, a

depressing number of courses had faded from memory. At times, students did not even recollect having taken them. Is that evidence that they learned nothing from those courses? Of course not. Should we be concerned by reports like that? Absolutely.

Are we satisfied with the notion that students forget a significant amount of what we once held them responsible for knowing? If we take learning seriously, we must take responsibility for the ubiquity of amnesia. We need to reexamine much of what we teach, and how we teach it.

Fantasia is the name we have given to what otherwise might be called illusory understanding or persistent misconceptions. Fantasia is potentially far more insidious than amnesia. With amnesia my attitude is to let bygones be bygones. What you have simply forgotten may be harmless. But fantasia can be dangerous. It is that state in which students are absolutely confident that they understand something, but they don't.

You may have seen a short video in which graduating Harvard students were asked to explain why there are changes in the seasons. Nearly every student responded with supreme self-confidence that the orbit of the earth is elliptical and that, therefore, the earth is sometimes closer to the sun, hence summer, and sometimes farther from the sun, hence winter. They exemplified the condition of fantasia, the confident grasp of an idea or explanation that is fundamentally at odds with the most warranted conceptions held by experts. These illusions may have been based on widely accepted folklore that had become a prevailing preconception. They may have developed from a formal lesson that had been assimilated, memorized, but never accurately understood. These misconceptions are important for several reasons. New learning rests on old learning. A strategically held misconception can interfere with significant amounts of later good teaching. In that sense, misconceptions become insidious, a sort of intellectual land mine (or perhaps a "mind mine"?).

There is plenty of research--especially in science education-about the impact of illusory understandings. Many of them may not be a cause for alarm. An entire population can live happy and responsible lives bearing the heavy burden of illusions of understanding about the causes of seasons. But fantasia may also cause serious problems. Medical students who took literally the explanation that the heart functioned just like a pump later displayed frequent misunderstandings of how to deal with serious forms of cardiopathology.

Biology teachers must wrestle with the durability of student misconceptions of evolution and natural selection. Most students in courses that emphasize evolution and natural selection enter these courses as intuitive Lamarckians. They are convinced that any characteristics acquired by one generation are then transmitted to the next generation. The formal instruction emphasizes the Darwinian refutation of that position. These students may earn A's and B's in the course, demonstrating that they now understand the Darwinian perspective, but quiz them three months later and they're once again dedicated intuitive Lamarckians--as indeed are many of the rest of us. I suspect that forms of fantasia are endemic among students and graduates of higher education, many lying in wait for years before manifesting themselves at critical moments.

What about *inertia*? I take the word "inertia" from Alfred North Whitehead's lovely pun about "inert ideas" that occupy much of the space in our well-educated minds. A play on Plato's concept of "innate ideas," inert ideas are those that simply lie there, doing nothing. They are not forgotten; nor are they in some intrinsic sense wrong. They are simply not in a form that lends them to any useful purpose beyond being remembered.

For me, the best example of inertia is documented in research conducted in the 1950s by one of my mentors at the University of Chicago, Benjamin Bloom, on problem-solving processes in college students. Bloom was serving as the University Examiner, a role that led to his well-known contributions to the Taxonomy of Educational Objectives. Using the taxonomy, he identified a number of students who had acquired substantial amounts of "knowledge" of a subject, but could not apply that knowledge, or use it to analyze or synthesize new understandings.

Bloom identified two groups of students who had completed an American History course. Both groups had performed equivalently on the test items that measured knowledge of the facts of history, but one of the groups had excelled in measures of higher-order understanding while the other had floundered on problem-solving questions that required them to apply that knowledge to new situations. Bloom wanted to understand how two groups of people, who apparently knew roughly the same things, could be so very different in what they could do with their knowledge.

Bloom invited the students to think aloud when confronted with a question like this: "What do you think would have been the attitudes of Virginia tobacco farmers toward the new Constitution of 17897" That particular "fact" was nowhere to be found in the students' reading or lecture materials. The students who had performed well on the problem-solving questions would say things like, "Well, I don't remember anything in particular about that, but let me work my way through it. The Virginia tobacco farmers, well, what would they have had a stake in? Let's see, they would have been very dependent on both inter-state and international trade because they'd want to be able to sell their crop. A strong federal government might well be in their interest." As students reasoned their way through reviewing what they knew about the differences between the Articles of Confederation and the new Constitution, the consequences for the relationships among the states, and so on, they would weave together conjectures about the attitudes of tobacco farmers that were well grounded in evidence.

The students who "knew" the information but had not performed well in application would say things that would sum up to: "You want to know about the attitudes of these farmers? Hey, I'm sorry. We didn't study that." Those students are probably the ones likely to complain about how unfair it was for teachers to test them on things they had never been taught.

I emphatically am not saying that the "facts" don't matter. Absent the facts, any of these students would simply be fabricating. They wouldn't have a clue. You need facts to make sense; they are the basis for understanding, but they are never enough. Inertia as pathology describes those states of mind where people come to know something but

simply can't go beyond the facts, can't synthesize them, think with them, or apply them in another situation. Since the ultimate purpose of any education is to help students to go well beyond the limitations of any formal instruction, the epidemiology of inertia should comprise a serious domain of institutional inquiry for higher education. Any institution that claims to take learning seriously must systematically monitor the circumstances of amnesia, fantasia, and inertia associated with its programs. Alas, most of our institutions are similar to hospitals that proceed blithely along well-traveled paths oblivious to the mortality and morbidity rates experienced by their patients.

In our attempts to understand the conditions that foster amnesia, fantasia, and inertia, and in trying to understand how to combat those problems, we unexpectedly stumbled over *nostalgia*. We found nostalgia not so much among students as among teachers, administrators, critics of education, and political leaders. This condition is marked by a common symptom-the firm belief that whatever the educational problem, the best way to combat it is by reinstating the ways through which the observers had been taught when they were the same age as their students. To teachers, the problem with modern education was that it was somehow riddled with new fads like group work, project-based learning, and--oh my!--service learning. Why can't we just get back to lectures, with an occasional discussion session? Why can't we just emphasize important facts, basic skills, fundamental principles, and the universal moral values? To the lay critics and policy-makers, the solution involved returning to the rigor of yesteryear: tougher standards, punitive grading systems, and less tolerance for the mushy, politically correct additions to the bedrock of the traditional curriculum.

One of the problems is that those who are trying to remedy the aforementioned afflictions usually believe that the reason people forget, misunderstand, or go inert is that they haven't been taught enough, and that the answer is to teach them more. You can often see aspects of this "solution" in the one piece of pedagogy that is a true partnership between higher education and K-12: advanced placement. "AP" is exemplary in many ways. It is a lovely example of standards-based teaching and learning in which the teacher truly serves as a coach who supports all the students in their quest for the highest levels of performance. The test is external to the classroom and does not interfere with that cooperation between teacher and students. However, many AP exams such as Biology and U.S. History seem driven by the principle that, not "less is more," but "much more is more." The content coverage of those courses is astounding in its magnitude.

We were shocked by the results of the publication of the Third International Math and Science Studies, where for the first time we compared our advanced placement students--the créme de la créme of American students--against the best students in other countries. We learned that the coverage strategy just doesn't work. Our kids don't match up well with their international counterparts. The very best explanation for the differences in performance lies in our very different ways of teaching. We define rigor as teaching our students more, however superficially. Other countries bring a much smaller set of ideas to students, then elaborate and deepen them pedagogically. They don't cover as much material, but the students understand more robustly what they have studied. If we are to take learning seriously, we will have to find another strategy to replace nostalgia.