

3-Part Series on developing your metacognitive skills

- #1: Succeed with your strengths: Assess and apply your unique strengths to improve your chances for success in grad school
- #2: Assess your communication strengths with the Myers-Briggs types and apply them to work effectively with others
- #3: Succeed through your failures: Learning to fail productively in grad school

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Succeed through your failures:

Learning to fail productively in grad school



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 Fall 2012

We all fail.

But how will you respond?

Let's consider:

Case study & psychology research

Bio professor & sociology study

Economist

who says:

your response to failure reveals your mindset

research can make you feel stupid

trial and error and the god-complex

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Activity 1

Read Tony's story about his start to grad school and discuss in groups

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How do you respond to failure?

Carol Dweck reports on 2 different responses:

● Fixed mindset

- I'm a total failure
- stay in bed
- get drunk
- I wouldn't bother trying hard next time

● Growth mindset

- I'd look at what was wrong and resolve to do better.
- I'd start thinking about studying in a different way.

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Carol Dweck's Mindset

Fixed vs Growth

ability is static

- avoids challenges
- gives up easily
- sees effort as fruitless
- ignores useful criticism
- threatened by others' success

ability is developed

- embraces challenges
- persists in obstacles
- sees effort as necessary
- learns from criticism
- inspired by others' success

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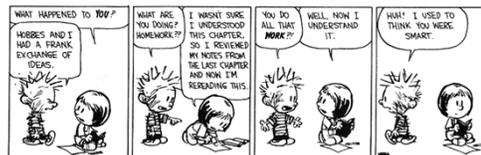
What are the consequences of a growth mindset?

- Those with a growth mindset:
 - achieved higher grades in a General Chemistry course
 - had a more accurate sense of their strengths and weaknesses
 - had lower levels of depression

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Dweck reveals a false dichotomy

The fixed mindset says either you have ability or you expend effort. Effort is for those who don't have the ability. People with the fixed mindset tell us, "If you have to work at something, you must not be good at it."



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Activity 2:

Read the paper and discuss in your groups

"The importance of stupidity in scientific research"

Martin Schwartz, *J. Cell Science*, 2008, 1771.

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Incoming grad students face new challenges in research

"Doctoring Uncertainty: Mastering Craft Knowledge"
Delamont and Atkinson, *Social Studies of Science*, 2001, 87.

- as undergrads, they were accustomed to smaller projects with a high chance of success
- many new grad students face greater difficulties with bigger projects
- when scientists present or publish research, we marginalize our failures

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Activity 3:

Watch Tim Harford's TED talk

Trial and Error and the God Complex
by Tim Harford

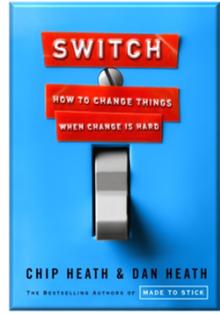
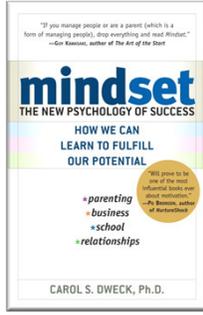
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Your "homework" is to reflect and/or discuss:

- a past experience in which you failed miserably
- when you got very fearful or angry
- what are you anxious or fearful about in your future?
- do you think you have a fixed or growth mindset?
- if you've never really failed, ask why not? are you perhaps so afraid of failure that you don't take good risks?
- do you have someone who honestly points out your weaknesses and helps you to improve?

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Resources



Sticky Message

We all fail.

How you respond makes all the difference

Dweck – growth requires effort

Schwartz – research makes you feel stupid sometimes

Harford – beware of the god-complex



Succeed Through Our Failures: Learning to Fail Productively

Activity 1: Tony's First Semester of Grad School

Tony had been feeling excited about starting grad school, because he did well as an undergrad. He completed his bachelor's degree in three and a half years, had multiple research experiences in industry and academia, and earned a co-authorship on a publication. But in his first semester in grad school, he failed a critical class and was deeply disappointed. *Carefully read about Tony, who is based upon a real student, to analyze his situation and consider how he can improve.*

Tony had always done well as a student. During high school, he completed many Advanced Placement courses and received college credit for them. This allowed him to skip many first-year courses as an undergrad, and start with second-year courses. His start to college was a little rocky because he was taking classes with sophomores, but he earned A's in his major. He later took two grad-level courses and earned A's in both of them. He completed his bachelor's degree in 3.5 years with a GPA of 3.2.

Because of his early start, he also started doing research early. He worked for two different labs at his college, and one project led to a co-authored publications. He also completed three internships in industry to expand his experiences.

Tony knew that this undergrad institution was not ranked the highest in his field, but he still felt confident because of his past successes. His new grad school was ranked in the top ten nationally, and so he expected an increase in the rigor and standards among the grad students. He was a little uncertain of how he might do in the coursework, but his application for grad school went through smoothly, and so he felt confident.

As he began grad school, he continued similar extracurricular activities. He played on the school's ultimate frisbee team and biked with the local cycling club regularly. He took his sports seriously, and so worked out daily. This didn't allow time for studying with friends, but Tony preferred to work and study alone.

For Tony's first semester, he had to juggle coursework, looking for a research group to join, and TA-ing. The coursework and research felt similar, but he had never TA-ed before. He was afraid to embarrass himself in front of his

students, but he devoted a lot of time and energy in his preparations to help him feel more confident and comfortable.

His grad school was also significantly bigger than his undergrad institution, so he felt more like a number among all the other grad students. He didn't really connect with his classmates, but he preferred to hang out with his roommate, who was a friend from his undergrad institution.

As Tony studied for his courses, he was unaccustomed to the teaching styles. The faculty didn't closely follow the textbook, and instead used lots of journal articles.

Overwhelmed with all the reading, he was uncertain about what to focus on. After the first exam, he realized that he was having trouble because his score was below the average. But he wasn't exactly sure what his score meant. He heard that faculty generally gave out mostly A's and B's, but C's were also given to those students at the bottom. The faculty didn't clearly correlate scores with letter grades, but Tony didn't feel comfortable approaching the faculty and asking if he was in the C range.

For the final exam, Tony realized that he needed to improve. So he started working out less, and studying more. But juggling all of his activities had been difficult, so he arrived at the final exam late. He had a hard time focusing on the final, but did his best.

A few days after the final exam, his PI called him into his office and closed the door. He told Tony that he had actually the lowest score on the final, and gotten a C in the course. Tony didn't know what was worse: his poor performance, or the fact that his PI now knew of his failure. He felt ashamed also when he had to tell his parents about the failing grade.

During the Christmas break, it was hard to feel motivated to do much. He was deeply discouraged, ashamed, and tired. Tony had never gotten an F, or even a D before. So he didn't quite understand what he was feeling and what to do. In his program, he would need to repeat the same course and earn an A. But he felt embarrassed that he would be taking the course as a 2nd year student among 1st years.

- Analyze Tony's transition. What were some similarities and differences for Tony between his undergrad and grad school? What are some important differences in general for most students, and for you?
- Analyze Tony's self-assessment and metacognitive skills. Do you think he had a good assessment of himself, his peers, and his new situation in grad school? What are some simple things he can do to improve his self-assessment?
- As Tony prepares to repeat this course, what do you think he needs to do differently to improve?

The importance of stupidity in scientific research

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Accepted 9 April 2008
Journal of Cell Science 121, 1771 Published by The Company of Biologists 2008
doi:10.1242/jcs.033340

I recently saw an old friend for the first time in many years. We had been Ph.D. students at the same time, both studying science, although in different areas. She later dropped out of graduate school, went to Harvard Law School and is now a senior lawyer for a major environmental organization. At some point, the conversation turned to why she had left graduate school. To my utter astonishment, she said it was because it made her feel stupid. After a couple of years of feeling stupid every day, she was ready to do something else.

I had thought of her as one of the brightest people I knew and her subsequent career supports that view. What she said bothered me. I kept thinking about it; sometime the next day, it hit me. Science makes me feel stupid too. It's just that I've gotten used to it. So used to it, in fact, that I actively seek out new opportunities to feel stupid. I wouldn't know what to do without that feeling. I even think it's supposed to be this way. Let me explain.

For almost all of us, one of the reasons that we liked science in high school and college is that we were good at it. That can't be the only reason – fascination with understanding the physical world and an emotional need to discover new things has to enter into it too. But high-school and college science means taking courses, and doing well in courses means getting the right answers on tests. If you know those answers, you do well and get to feel smart.

A Ph.D., in which you have to do a research project, is a whole different thing. For me, it was a daunting task. How could I possibly frame the questions that would lead to significant discoveries; design and interpret an experiment so that the conclusions were absolutely convincing; foresee difficulties and see ways around them, or, failing that, solve them when they occurred? My Ph.D. project was somewhat interdisciplinary and, for a while, whenever I ran into a problem, I pestered the faculty in my department who were experts in the various disciplines that I needed. I remember the day when Henry Taube (who won the Nobel Prize two years later) told me he didn't know how to solve the problem I was having in his area. I was a third-year graduate student and I figured that Taube knew about 1000 times more than I did (conservative estimate). If he didn't have the answer, nobody did.

That's when it hit me: nobody did. That's why it was a research problem. And being *my* research problem, it was up to me to solve. Once I faced that fact, I solved the problem in a couple of days. (It wasn't really very hard; I just had to try a few things.) The crucial lesson was that the scope of things I didn't know wasn't merely vast; it was, for all practical purposes, infinite. That realization, instead of being discouraging, was liberating. If our ignorance is infinite, the only possible course of action is to muddle through as best we can.

I'd like to suggest that our Ph.D. programs often do students a disservice in two ways. First, I don't think students are made to understand how hard it is to do research. And how very, very hard it is to do important research. It's a lot harder than taking even very demanding courses. What makes it difficult is that research is immersion in the unknown. We just don't know what we're doing. We can't be sure whether we're asking the right question or doing the right experiment until we get the answer or the result. Admittedly, science is made harder by competition for grants and space in top journals. But apart from all of that, doing significant research is intrinsically hard and changing departmental, institutional or national policies will not succeed in lessening its intrinsic difficulty.

Second, we don't do a good enough job of teaching our students how to be productively stupid – that is, if we don't feel stupid it means we're not really trying. I'm not talking about 'relative stupidity', in which the other students in the class actually read the material, think about it and ace the exam, whereas you don't. I'm also not talking about bright people who might be working in areas that don't match their talents. Science involves confronting our 'absolute stupidity'. That kind of stupidity is an existential fact, inherent in our efforts to push our way into the unknown. Preliminary and thesis exams have the right idea when the faculty committee pushes until the student starts getting the answers wrong or gives up and says, 'I don't know'. The point of the exam isn't to see if the student gets all the answers right. If they do, it's the faculty who failed the exam. The point is to identify the student's weaknesses, partly to see where they need to invest some effort and partly to see whether the student's knowledge fails at a sufficiently high level that they are ready to take on a research project.

Productive stupidity means being ignorant by choice. Focusing on important questions puts us in the awkward position of being ignorant. One of the beautiful things about science is that it allows us to bumble along, getting it wrong time after time, and feel perfectly fine as long as we learn something each time. No doubt, this can be difficult for students who are accustomed to getting the answers right. No doubt, reasonable levels of confidence and emotional resilience help, but I think scientific education might do more to ease what is a very big transition: from learning what other people once discovered to making your own discoveries. The more comfortable we become with being stupid, the deeper we will wade into the unknown and the more likely we are to make big discoveries.

- What does Schwartz point out as some important differences between school coursework and research?
- What are the various definitions of "stupid" in this article?
- As Schwartz approaches his research, do you think he has a fixed or growth mindset? Explain your reasoning.