Capturing the student perspective through the eyes of an 'expert' and professor

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Introduction

Origins, Backstory, and Goals

It is easy for a professor to forget what it is like to be a student and the details of the struggle a classroom may bring. The goal of this paper is to share the internal tensions I experienced as a student with the hope it may shed light on how a 'typical' student may be experiencing an engineering classroom. This paper emerged as a qualitative research project for one of my classes, in a semester in which I was also reengaging with 'hardcore engineering topics'. Being a long time professional, I was surprised at how often an otherwise logic driven classroom evoked an emotional response. Through this paper I will discuss the role of emotion in learning and motivation and how that played into my semester back in traditionally engineering classrooms. As a professor, it is easy to forget what it is like to experience these materials for the first time. As a 'solid student' from a strong educational background, I seldom experienced times where my background left me ill-prepared for the class. I hope to look at both what theory tells us about how students react to typical classroom events and provide examples of how this feels and what it might look like through my experience.

I returned to grad school three years ago to pursuit a PhD in Engineering Education having completed an online Master's degree in Information Technology in 2009. I also work full time as a software engineer/architect, having graduated in the mid-nineties with an Electrical Engineering (EE) degree. My journey has been from undergraduate student to industry, and back to graduate student again, moonlighting as an adjunct professor, and returning to grad school to become a researcher. Today I take on all four roles at once, as shown in Figure 1. Before the semester being described in this study, my classwork has been focused on research methods, educational theory and the scholarship of teaching and learning. The study of learning makes it nearly impossible to return to engineering centered courses without reflexively considering the experience and resist the urge to document it.

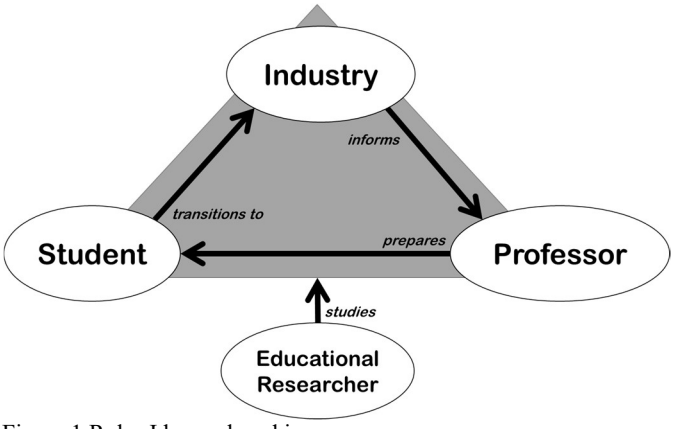

Figure 1 Roles I have played in my career

This study began with a host of potential research questions, but in true qualitative practice a commitment to the process above any specific outcome. I selected an auto-ethnographic approach, with loose ideas of a research question centering around perspectives of a student with industry, teaching and educational research experience. My master's degree was a subject which I already felt quite competent because of industry experience and not particularly pedagogically rigorous. This term's engineering classes were driven by advanced math and would expect expertise I had not used in 20 years. I presumed I would struggle, and see reasons I did so from theory, but committed to letting the data collect and see where it led me.

Each course included ideas I resonated with and rejected, but the intellectual analysis of how teaching occurred was less salient than how it made me feel. I promised I would not simply evaluate the ways the "*institute* is doing it wrong". I took notes capturing where theory and approach conflicted, but the pedagogy approach was overshadowed by how I *experienced* it and *felt* about it. I was shifted from a place where I was at or above the average of my peers to woefully behind. To even keep pace, I needed to relearn much of the math my classmates could quickly and easily perform. This provided a new perspective on how other students may have perceived teaching back when I was a 'hot shot' running through the traditional curriculum.

This paper is focused on the co-mingling of my emotions and learning through two graduate Electrical Engineering courses. The next section will review literature around expert/novice differences, the role of emotions in learning, and how these tie into self-efficacy theory as a framework for describing my experience. While my experience is more complex and my background non-traditional, by framing them in theory and being trained to capture these metacognitive insights, I hope to share how these engineering classrooms impacted my learning, outlook, and future in unexpected ways.

Literature Review

Students experience and react to the classroom based on their interactions with instructors and the materials provided. While engineering classrooms are generally based in fact and proven knowledge, the way topics are presented make assumptions about the prior knowledge and experiences of students and tangentially who those students are. Thus, understanding what it is to be 'expert' and the relationship between experts and novices is key to how students might react to the course materials and instruction. As students have emotional reactions to materials, it complicates learning. Psychology and neuroscience can show how learning is impacted by emotion, even for subjects that are not traditionally considered emotional. Emotions may be a vital part of learning and applying learning and likely should be considered in all classrooms. Emotions play a strong role in student motivation and development of self-efficacy. How a student feels about their competency can impact if they will learn, apply, or even choose to leave engineering. The experiences captured in this study can be framed and perhaps explained by looking at the interaction between experts and novices, the role those emotions may play and the impact on self-efficacy.

The problems of novices and experts

One of the hardest things about getting "good" at something is you often forget what it was like to be new to it. This is sometimes called the 'expert blind spot' and shows up when

> *"educators with advanced subject-matter knowledge of a scholarly discipline tend to use the powerful organizing principles, formalisms, and methods of analysis that serve as the foundation of that discipline as guiding principles for their students' conceptual development and instruction, rather than being guided by knowledge of the learning needs and developmental profiles of novice"* [1, p. 906]

In other words, an expert tends to see the world in a much different way than novices do, relying on precursor skills the expert may have forgotten they mastered. As an example comparing novices and experts, Wiedenbeck [2] found that novices programmers are slower and less proficient at even simple memorization tasks such as syntax rules in a programming language,

compared to experts. Wiedenbeck employed tests which required little more than recognizing syntax (i.e. words in the language) and their associated meanings expecting novices to do as well as experts. The experts' experience and practice set provided noticeably better than students who simply had to memorize the same facts. Experts could more easily recall and more quickly answer simple questions on syntax, much less perform better on complex analysis tasks which experts would clearly have an advantage. Experts must go beyond recognizing syntax, as a programmer must build working code and design novel solutions using the language. Even if novices can memorize rules and build simple applications, Kinnunen & Simon found "[s]ubmission of a working program only means the student could produce a working program, not that they always feel they understand the underlying concepts or the process of programming" [3, p. 25]. Complex concepts may require some level of mastery in precursor skills, such as syntax rules, before they themselves can be mastered, but mastering the precursor skill is not evidence of conceptual understanding. Wiedenbeck was only testing precursor expertise that novices share with experts, but a long way from the full skillset they would be expected to know.

Hatano and Inagaki [4] would categorize the syntax of programming languages to be procedural knowledge, which when mastered develops routine expertise. "[R]outine experts are outstanding in terms of speed, accuracy, and automaticity of performance, but lack flexibility and adaptability to new problems" [4, p. 30]. It is possible for students to become experts in coding, math, or other educational skills, but these are not the ultimate concepts and skills experts utilize in advanced engineering designs. Hatano and Inagaki describe adaptive experts as "those who not only perform procedural skills efficiently but also understand the meaning of the skills and nature of their object" [4, p. 28]. Experts, particularly college professors, have trained for years in their chosen field and have developed routine expertise in a variety of precursor skills, combining those skills in novel ways. Many projects have given experts experiences providing alternative views at the concepts in action, experiences impossible to relay to students through instructions alone. The expert's blind spot stems from the unlikelihood they remember the individual experiences and struggles that helped formulate their expertise. They may expect students remember taking the same classes and thus expect students to remember the same details, which Wiedenbeck's study showed was unrealistic for coders. More so, they expect students have the ability to transfer and apply knowledge built upon those skills, which Hatano and Inagaki would say only happens through "accumulated practice of procedural skill" [4, p. 35]. Professors portray their expert blind spot when they forget what it is like to learn a new subject.

When experts forget the process by which they learned themselves, it can lead to unfair expectations from students. If learning requires varied experiences [5], an instructor must make tradeoffs between breadth of knowledge and depth of skills in the classroom. Should a class cover all the materials an engineer may face in the field, or omit certain branches of knowledge to build deeper expertise in a few? Students do not generally transfer knowledge well, relying on surface features over deeper problem structures rather than being able to apply concepts. In a classic example on transfer deficiencies, Perkins and Salomon [6] describe how physics students were unable apply the concepts from a homework problem to a test. The problem asked students to calculate the time it takes a ball to fall 100 feet from a tower to the ground. The test problem asked students to calculate the time it took a ball to fall 100 feet to the bottom of a hole. When presented this way, even readers with little experience in physics may see gravity applies equally

to towers and holes, but for students who only have experienced a single example, they could be entirely different. If a professor attempts to test conceptual understanding through a question requiring transfer, they are forgetting that experience, not instruction is more likely to create conceptual knowledge. It is rare for novices to see a hole as equivalent as a tower when stuck in new ideas, no matter how obvious it is from the outside. Fundamentally, Experts recognize problems differently than novices. Remembering knowledge is not the same as being able to apply it later.

> *"Because experts seem to rely on problem types to invoke analogous problem schemata, an ill-defined problem, which does not fit into a recognized problem type, requires frequent restructuring or the use of other search strategies besides analogical reasoning in order to develop an adequate solution"* [7, p. 16]

Novices cannot recognize problem solving strategies from memorizing the rules alone, and they cannot develop the adaptive expertise without a variety of challenges on a common concept. Experts have the advantage, whether they remember or not, of many experiences and problems solved and the struggles and triumphs along the way to form and contextualize concepts in their memory. When an expert forgets that a novice also needs a variety of challenges, they fall prey to a blind spot and can risk damaging more than a student's learning outcomes.

Emotions and Learning

Emotions are inextricably tied to learning. In early learning theory, "[Piaget] repeatedly states that no act of intelligence is complete without emotions" [8, p. 14]. Emotion interacts with not only our learning but applying our knowledge as well. Neuroscience shows "neither learning nor recall happen in a purely rational domain, divorced from emotion, even though some of our knowledge will eventually distill into a moderately rational, unemotional form" [9, p. 7]. New information is colored with emotions we are feeling at the time. Only through repeated experience does a learner move past the emotions attached to memory and use knowledge decontextualized. A student can have a drastically different outcome in a classroom depending on their emotional state. For instance, test anxiety can alter student performance because the mind recalls information differently with and without fear. "[T]hese circuits process different inputs in emotional vs. nonemotional conscious experiences, and in different kinds of emotional experiences" [10, p. 2]. The knowledge a student stores away in the comfort of their dorm room or comfortable classroom can easily be inaccessible when they see an unfamiliar test question and panic. A question that seems perfectly clear to an expert may not only be unfamiliar to novices, but induce unintended emotions which impact performance and learning.

Emotions tie directly developing and even using expertise. We saw before, students generally categorize problems by surface features and are unable to recognize a problem's underlying conceptual structure. They see towers and pits instead of falling balls governed by gravity. Immordino-Yang & Damasio [9] believe emotions govern how memories are formed and recalled. More profoundly, they believe that attempting to remove emotion from learning could remove the adaptive expertise required to transfer concepts across different types of problems. Studies show people, who fully possess the knowledge required to make 'good decisions, sometimes make inexplicable choices due to brain lesions in the prefrontal cortex which inhibits their emotion centers. "[T]hese patients' social behavior was compromised, making them oblivious to the consequences of their actions, insensitive to others' emotions, and

unable to learn from their mistakes" [9, p. 4]. A student may possess all the knowledge they need yet be unable to recall and apply that knowledge when they are in an emotional state. Being upset and full of doubt may impair cognitive abilities just enough to underperform in the moment, which could lead to a bad grade and cascade from there.

A frequent concern of teachers is the academic honesty of students, to the point where they formulate assessment to maximize likely integrity. Even in highly complex subjects, which require multiple formulas, exacting procedures and perfect calculations, professors will choose to ban computers, books, and even student generated notes to ensure what they feel is a 'level playing field'. These measures often alter assessment tasks until they bear no resemblance to the authentic tasks student will be asked to perform in industry where computer assisted calculations would be mandatory, not prohibited. Kidwell, Wozniak, & Laurel report that students do admit to certain types of cheating, but "faculty believed a few cheating behaviors to be more common than perhaps they are. These related to uses of technology to facilitate cheating, including using Internet term paper sites and copying computer programs" [11, p. 210]. Students were more likely to slide on creating appropriate citations, collaborate outside class when they were told not to, or copy on a test, but unlike to employ drastic computer cheats. To prevent cheating, faculty may be adding stress and fear to some students, inducing emotions that would instead cause bad decisions such as cheating, rather than giving paths toward learning.

Faculty must balance positive and negative emotions in the classroom. In an essay considering the nature of safe spaces in the classroom Rom states "learning necessarily involves not merely risk, but the pain of giving up a former condition in favour of a new way of seeing things" [12, p. 399]. Learning involves discomfort as a student moves away from comfortable understandings and builds new skills, but if that discomfort becomes excessive the student will stop learning. Arao and Clemens [13] suggest an alternative to safe spaces they call 'brave spaces' for learning. While safe and brave spaces tend to be focused around education dealing with social justice issues, I feel their concepts can be applied in any classroom. Arao and Clemons list five rules they suggest for making the classroom a brave space which I am coopting to apply in any educational setting.

1. *Agree to Disagree*- This may seem odd in a classroom where an expert is sharing proven rules of nature, but knowing the role of emotions, conceptual change may be no less dramatic be it rules of physics as they are social justice. A student will be more likely to accept and remember knowledge if they are given time and support in coming to the new way of thinking
2. *Don't take things personally*- This rule is extended beyond "no judgements" and "it's OK to make mistakes" typical in safe spaces. In a classroom, students will make mistakes, but it is also acceptable they have an emotional response to mistakes. It is not their responsibility to repress their emotions (or misunderstanding) to cater to the expert's (and ultimate authority's) possible missteps. It is important a teacher can prove acceptance of learning struggles and that they are a supportive partner, rather than an authority to be mollified.
3. *Challenge by choice*- In brave space context, this is the choice of the participant to engage in group activities, but how can a student be given the choice to engage in vital assessments? Instead, the choice can be framed as agency in the path and modes of learning. Too often instructors only provide one mode of learning (typically lecture) and demand attendance, note taking, and lock step progression. Alternative

pedagogical choices could allow students to engage the materials from a variety of paths, even as they must meet common mandates.

4. *Respect*- This seems obvious and would hardly be argued by even the most bitter professor, but is it always mutual? Do teachers respect the student's time as much as they expect their own? What subtle ways do the power differential betray a different expectation of respect?
5. *No attacks*- Again this may seem obvious, but an attack may be perceived even when not intended. Students may form passive aggressive attacks through end of term surveys or social networking. Instructors may seem to attack when they make public announcements to all for issues only involving a few. Having no attacks as a rule, in conjunction with rule 2 allows for dialog rather than unstated embitterment.

The goal of these rules is to embrace the role of emotions in learning. By pretending they do not exist, students likely will learn less, perform worse on assessments, derail motivation, and potentially worst of all, impact our next topic: self-efficacy.

Self-Efficacy

Self-efficacy, an individual's belief in their likelihood to succeed, impacts learning in a variety of ways. Bandura says self-efficacy can determine "human motivation, affect, and action" as well as "may be self-aiding or self-hindering" [14, p. 1175]. Students enter the classroom with an identity that may strengthen or diminish their self-efficacy in that subject, but the instructor can set a tone to encourage growth. While the instructor cannot control the student's outlook, they can try to support self-efficacy or inadvertently create/reinforce negative perceptions in the student. Self-efficacy may be a self-fulfilling prophesy. Bandura cites a study by Berry who noticed "[t]he stronger people's beliefs in their memory capacities, the more effort they devote to cognitive processing of memory tasks, which, in turn, enhances their memory performances" [14, p. 1176]. The very fact an individual believes they have a good memory means they will work more in memory tasks, which in turn proves they have a good memory. Beyond effort, Bandura states people with strong self-efficacy will endure longer and experience less stress and depression in the face of obstacles. While part of a teacher's job is to honestly provide feedback through assessment, the mode of assessment (and all pedagogy) should consider how it impacts self-efficacy.

Bandura places self-efficacy in the center of a social context, not within the individual alone. Social Cognitive Theory tell us that an individual is not merely a machine responding to stimulus in the environment, but interact with the environment and adjust their own motivations and actions accordingly. Student may enter a classroom unmotivated, highly motivated or somewhere in between, but Social Cognitive Theory states the classroom environment impacts students just as students impact the environment. Individuals "tend to avoid activities and situations they believe exceed their coping capabilities, but they readily undertake challenging activities and select social environments they judge themselves capable of handling" [14, p. 1178]. Is it no wonder in some classes the first weeks see students withdraw as they assess, perhaps supported by the early observations, whether they are capable of success? It takes a rare student to persist in the face of a challenge they feel they cannot overcome, and people tend to prefer agency over their choices and environments rather than being mandated into learning circumstances in which they feel they will likely fail.

Methodology

Mode of inquiry

This study uses analytic autoethnographic as proposed by Anderson [15]. Generally autoethnography "seeks to describe and systematically analyze (graphy) personal experience (auto) in order to understand cultural experience (ethno)" [16, p. 273]. Anderson distinguishes analytic autoethnography from traditional approaches by adding five criteria:

> *(1) complete member researcher (CMR) status, (2) analytic reflexivity, (3) narrative visibility of the researcher's self, (4) dialogue with informants beyond the self, and (5) commitment to theoretical analysis* [15, p. 378]

In ethnography the researcher is also the participant, but in Anderson's view the researcher needs to be a fully invested member of the community being researched, not simply a 'fence sitter' observing the community. Analytic autoethnography is even more important as I as the subject and an active student can express report my honest emotions, rather than make inferences based on observations or rely on other participants to accurately reflect on and report their emotions. It is equally important however to ground the emotions I have in theory and triangulate against other sources as no to simply report on feelings. Reviewing the criteria Anderson proposes this study meets the requirements for analytic by the following:

1. I was a fully enrolled and graded student, with 'skin in the game' as I am interested in the subject matter and the results will impact my GPA.
2. The data source for this analysis comes from a reflective journal I kept throughout the semester, documenting impressions from class, homework, tests or other interactions throughout the semester.
3. This study is not reporting on classroom dynamics, but on my experience as a student while being lectured to, assessed, and interacting with peers and instructors.
4. I engaged with each instructor on my background and goals in the course. I continued to meet regularly one of the instructors during office hours sharing my observations and seeking insight and explanations on their pedagogical choices. Additionally, my impressions are weighed against questions I asked classmates who approached me to work on course materials.
5. The final criteria Anderson proposes is to engage in an analytical agenda by using "empirical data to gain insight into some broader set of social phenomena than those provided by the data themselves" [15, p. 387]. It is not simply enough to tell the story, but to see what aspects of the data can tie into larger theory and insights as presented in the literature review.

Methods Overview

This study took place across the 2017 Fall Semester at a large Midwestern research institute. The only participant is the researcher, reporting on my experience in two EE graduate courses, each a 'numbered' course in the Electrical and Computer Engineering catalog and taken by graduate and final year undergraduate students across disciplines as electives. They do not state prerequisite courses, but certainly presume prerequisite knowledge. The contents of the class are not discussed in detail as the goal is to describe my reactions to the classroom, not to analyze specific choices in teaching.

The primary data source is my reflective journal started roughly three weeks into the class and continuing through the 16 weeks, which consisted of 32 different entries and just over 9800 words. I generally added reflections two to three times a week, right after a class, but also did so if something salient occurred I wished to document. The impressions of 'others' were captured in journal rather than separate data. I did not want to alter my relationship from peers in the class into participants in the study, which could change the authenticity of our conversation. This has the limitation of perhaps biasing their words, though I attempted to capture exact wording where possible. In my analysis I also referred to course documents, emails, and inevitably, memories and reflections not captured in, but supported by, the journal.

Data analysis started with reading and reviewing the journal, coding specifically emotional responses captured in the writing. To set the frame for my observations: I am a 40 something, white, cisgender male from the Midwest working on my third collegiate degree. I have twenty plus year of industry experience, eight years as an adjunct faculty member, and am in school by choice as I continue to work a full-time job with a comfortable upper-middle class income. I feel this is important to state as I likely have little in common demographically with most of my classmates, and could be considered a closer peer to the instructors. My identity could bias the observations and analysis, so I ask you as the reader to provide balance and perspective I may have missed in reporting.

Results and Discussion

A Tale of Two Courses

The two courses provide a nice range of classroom approaches to compare against as traditional and more modern approaches to teaching and assessment. By providing some detail on my impression of the professors and how the classroom functions I hope to give context to my observations and show how emotions can vary in traditional and alternative approaches to pedagogy. It may also reflect on how my attitudes in each course vary as I feel, as discussed next, the instructor's personality and instructional choices seem unrelated and maybe even contrary? I also hope to show, in the risk my observations may be taken as entirely negative, that I genuinely enjoyed both classes, satisfactorily passed each, yet still have been profoundly impacted by the experience.

The Traditional Engineering Classroom

The traditional classroom lives up to its name in nearly every way. The course was lecture driven for 75 minutes two days a week, with the instructor using some PowerPoint but mostly spending time working formulas on a black chalkboard. The classroom was in an old engineering building, partially updated, with very modern projection technology yet lighting controls so old you could hear the relays click when they were turned on or off. The desks were traditional chairs with unmoving desk space affixed to the right, and furthermore each row of seats is bolted together so all 4 chairs in that segment are a fixed distance apart and move as one. The class started at roughly 35 students but dropped to just over 20 within the first two weeks.

Assessment consisted of a 'to be determined' number of homework assignments (ended up as six) for 50 points, two tests (100 points each) covering specific predefined chapters, and scheduled based on the pace of lecture, and a computer simulation project (100 points). The rubric was flexible; if you scored above 90% you were assured an A, but the rest of the grades would be determined based on student outcomes. Homework was turned in by hand, and tests

were completed in class with no calculators, books or notes. Work was graded by hand with a 'red pen' at first by a grader but eventually by the instructor himself.

The instructor, a full professor I will call Dr. T for "traditional", is prominent in the field for the subject matter being taught. He set and kept regular office hours, occasionally prompted for questions in class, and at the end of each topic/chapter took time to review the materials, even going back and covering subjects again that were issues on homework/tests. I found him to be enjoyable to talk to, if a bit guarded with his time, willing to engage in both discussion of the subject matter and the practice of teaching, but perhaps a bit cynical of alternative approaches to teaching.

I regularly checked in with Dr. T through the course and we talked about his approach, particularly assessments. He told me of attempts to use alternatives approaches in this course, and reasons each did not work. The most common response was "students did not like it" or that "it was too easy for students to cheat" for each failed alternative. He understood the need for integrity in testing and the challenges of assessing highly conceptual subject matter only represented in long formulas. We spoke several times my concern that pages of math calculations (one homework problem the solution was 14 pages!) missed evaluating conceptual understanding and catered to those with stronger math backgrounds. Dr. T agreed, but said "some student's, particularly Asian students, will just memorize the answers". His alternative is to throw "curve-balls" on tests, to see if we understood the concepts. Even as the course was very traditional, he has settled on this approach *after* exploring many alternatives and deeming them less effective or worth the effort.

Authentic Assessment Approach

The authentic assessment classroom is a hybrid of traditional pedagogy and revised assessment, constructed to be more authentic than tests. The class was held three times a week for 50 minutes in a larger classroom with raised seats of the same type described in the other class. The larger enrollment started at over 75 students but tailed off to around 50. The class had no book, and lectures consisted of the instructor talking, writing on the board, and mostly real time writing of source code. Most students did not use laptops, and none I saw attempted to code along with the instructor, but searched the web or maybe took notes. The instructor occasionally sent the code he was producing, but typically after several weeks of classes. The code in class was to cover the concepts of the subject matter but was not needed to complete any of the assessments.

The assessments consisted of three homework assignments, more of mini projects, and a final paper. The homework problems were due at the end of September, October, and November giving plenty of time to complete a moderate scale coding project. The final paper was handled like a mini-conference in the discipline. The paper required review of three articles from respected journals/conferences and some implementation of the technology from one of the papers or similar research. The intent was to provide students an authentic experience of what it is like to participate in the research community and to write, present and review papers at a conference.

The instructor is a long-standing associate professor I will call Dr. A for "authentic". He never published office hours, or a syllabus in any traditional form. He made it clear he had "someplace to be" quickly after class and would prefer all question to be address in class so other students could benefit from the answer as well. Dr. A basically shunned the university standard

electronic course room used post documents, submit assignments, and receive grades, delegating its maintenance to the teaching assistant (TA). The TA performed all homework grading, and managed the majority of questions to the instructor email list, which was the main mode of communication with the instructor(s). Dr. A did occasionally chime in to answer questions to the email list, but of the 160+ sent from instructors only 21 were from the professor and 10 of those were logistics or announcements.

Early on I did reach out a few times to talk to Dr. A before/after class. He generally seemed distracted, but not in an annoyed manner, just a person preparing for another task. I would typically pose questions before class (my questions were typically off the main lecture topic, so I wanted to let him choose when to address it) which he suggested I bring up in a few minutes, where he would address it for the group. I was under the general impression he was glad to come and teach, perhaps answer big questions in email, but satisfied to leave the homework to the TA[1]. For that reason, the lack of interest in initial conversations, and I did not know when/where to find the professor outside class, I did not engage further in discussion about the course as I did with Dr. T.

Stories of Self-Efficacy

Easy A does not mean I feel stronger as an engineer

My experience in Dr. A's authentic assessment classroom is mixed. I expected to do well in the class, felt confident in executing each of the assessments, and left the class literally with a perfect score. I cannot point to anything however I have learned which will stick with me from the class? The lectures started off as interesting, but the lack of active engagement with the materials, past observing, meant that not much stuck. After just a two-day break mid-term, I noted

> *"after a break I find myself not remembering much! We sit in class day after day passively collecting information and while it is all familiar while we [talk] the lack of doing means the details flutter" (October 11, 2017)*

This was not the first instance of concern about actively using the class materials as part of completing the homework or end of term paper:

> *"I had to miss [a class] due to a speaking invite at a conference. Upon returning today, I have no idea what was discussed Friday, and seemingly it is unrelated as we are continuing where we left off the week prior. With no book and no recorded lectures, the information is a mystery, and at best I am left to the notes of someone else. Given that I know nobody in the class, the students are primarily of a race not mine, mostly seemingly international, and the only other white students are also international, based on the accent, this seems like an interesting turn of events. I am the international student [it seems]. I must either make the uncomfortable overture to reach out, or choose to just let it*

[1] I spoke with the TA at one point after a lecture when the professor was traveling, and the TA lectured on the technology being used. The TA had no interest in an academic career, was glad to participate, but had no mind towards academics or teaching. I say this as I feel it removes any thought of the professor was grooming future faculty in the choices made to split the responsibilities in the classroom.

slide, which I think I will as little in the lecture seems to have anything to do with either the homework or the assessment." (September 18, 2017)

It was interesting to me that I was, in many ways, culturally isolated. Despite being a white male, I was from another department, knew no one, and did not "look like" most, and those I did, were not from the same country. I had no book or shared lecture notes from the professor, and despite the standard capability the class is not recorded. While I am far from underrepresented, I was not in a roomful of socio-economic peers or known cohort. I was in a sea of new faces and not sure if I shared any background or experiences. I believe this may be a similar experience for many international students or member of an under-represented group in a traditional classroom. An instructor may assume students use each other as a resource, yet despite the advantages I may possess in my stereotypical identity, it was still uncomfortable for me to reach out to peers to seek help, and I chose not to. I was a little afraid to seem uninformed, but more so unmotivated to bother as I did not know if I needed the information, or how it would relate or be used in the future.

The lack of connection between pedagogy and assessment continued to distract from lectures. The "entirely passive learning style that has me not [even] worrying if I catch the information as it won't be tested or even assessed in homework" (September 29 2017). Eventually my attention drifted in class, and my annoyance turned elsewhere "Have I mentioned before how much I hate these tiny seats? "(October 2, 2017). Eventually as homework problems arose, the extra information unrelated to homework in lecture caused dissonance.

"The thing that is confusing here is in the homework 1 and 2 we use totally different methods than what we are looking at in class. It is like trying to talk about the works of Dickens, but we read the English and Russian versions of two books and talk about the Spanish version of a third book in class. Yes, they are all Dickens stories, but we must context shift language and concepts, and not all students are fluent in all three representations!" (October 6, 2017)

My analogy shows the frustration I was seeing as the expert could easily blend in multiple instances of the domain, while as a novice I could see the relationships, but without practice could not clearly integrate the ideas. The instructor may have been trying to give multiple experiences with the information, but the lack of focused attention meant that I was confused and frustrated rather than growing.

In my estimation, Dr. A strives to respect the student and their knowledge, but in doing so may be evoking the wrong emotions and leaving self-efficacy unchallenged. Attention is vital to learning [17] yet students typically attend to what is being assessed. While the homework may have assisted in developing the routine expertise [4] needed to establish self-efficacy, the lack of integration between lecture (theory) and homework (practice) fails to build confidence required to make the transfer leaps needed in adaptive expertise. Dr A.'s authentic assessment is both brilliant and symptomatic of an expert blind spot. It is brilliant in that it is authentic and demands work of student that would typically contribute to self-efficacy. It is a blind spot, in that novices do not inherently possess the ability to connect theory to practice. An early task in the course required students to choose 'high quality' journal articles as a foundation of the final paper, but with no guidance on what quality means, or even enough foundation in the subject matter to determine appropriate topics to discuss. Students frequently asked for guidance on the

task in class, but Dr. A provided the most definitive and useful description of the desired results only three days before the paper was due! The authentic course work, which typically would build self-efficacy, did not leave me feeling any stronger in the subject matter as I am not entirely sure if I got lucky or just was already good at producing code and academic papers. I know that I cannot possibly remember the nuance, if even the main ideas, of the lecture, thus I would be loathe to consider myself proficient despite a perfect score as a result of taking the class. The course proved 'easy' but neither built self-efficacy, nor was satisfying, as opposed to my other course.

Two Experts and a Novice walk into a classroom

I humbly propose that I entered each classroom with deep expertise in one or more fields, but not remotely the ones being taught in the course. A twenty-year career being well compensated as an expert in my field provides a baseline of self-efficacy that a traditional student would not typically fall back upon. I willingly and gladly put any expertise aside to learn from each professor in their domain and felt it valuable to explain why such an non-traditional student was in the back of the room, resulting in an unexpected first conversation with Dr. T. After mentioning I was coming from an Engineering Education and returning from industry he suggested I should drop the course. Contextually, he had just signed two drop forms for other students, so he may have misunderstood my intent. I explained I was very interested in learning the subject so I could one day teach it, and so wanted to engage fully and participate in the assignments to hold myself accountable. Dr. T suggested I audit the class.

Here at our first detailed conversation, Dr. T seemingly expressed the belief, based on a few quick facts, I would not be able to complete the course work and I should drop or just watch. My self-efficacy, or maybe just ego, was strong enough to take the blow and I persisted. He may have been sharing his perception or experience that only certain types of people can succeed in this specific subject. He did not quiz me on specific skills or knowledge, or suggest extra work to prepare, but provided a quick frank assessment, which only on reflection and through literature do I see how unusual it is that I ignored. I do not feel he was expressing anything about my identity, but my perceived skillset. I wonder if other students would have so easily 'brushed off' his quick and frank assessment? I am not a member of an underrepresented group, who easily could associate their lack of expected educational background for a slight to their ability to participate. As an 'expert' in another field and "privileged white male", only casually noticed being so quickly assessed, but how many novices would be driven away from a cours or even field from such an unsupported assessment without any hope of participation? I cannot speak to why, but I can speak to the fact I had to make a conscious choice to continue to participate *against the stated opinion* of the gatekeeper of this knowledge.

Dr T. had several other occasions that I perceived as potential "diminishing statements" to the self-efficacy of students. In each case I feel Dr. T is providing an honest expert evaluation based on hundreds of experiences with students, with the goal to better prepare students. The way I experienced each of the following events was as a lack of belief in me as a student, if not a veiled attack to one of my peers or myself. Here are examples:

- Early in the term, Dr. T was trying to get us to view the domain in a new manner. He said, "Thinking in terms of <topic redacted> is like [high school thinking], we want to think in terms of <topic redacted> like graduate students". Using high school here was particularly salient to me as I just attended my 25th class reunion! Instead of inspired to

see this new knowledge in a new way I felt this statement a possibly 'shaming' into seeing things in a new way. I do not think the intent was to shame per se, but novices and graduate students are not mutually exclusive categories, and I felt it his job to show us the new way of seeing the phenomenon. Instead it felt like we were immature for not already viewing the materials in this manner.

- Later in the term he stated, "I went through today and corrected a bunch of typos … the students clearly did not read the class notes". Was he describing the prior year's students, implying we had not read the class notes yet either? This reveals an expert bias that when reading new ideas, it is easy to see mistakes. In fact, a few weeks later I was scouring the class notes studying for the test. Only by recreating the problems using a computer aided math application did I find several typos. Dr. T does not distinguish between how an expert sees things and how novices do, which I can say made me feel as if I were falling behind.
- Before the second test I captured the following:

> *"in class yesterday [Dr. T] announced that nobody else could take the scheduled test late as 2 people had already requested to, and it was too late. He said everyone in the class knew each other too well which certainly implied that those taking the test on time would support [cheating for] those taking it later. I know nobody else in the class, and I felt that it was a very presumptuous statement, and had I not known him better from conversations could easily have just took him as mean and arbitrary." (November 15, 2017)*

Cheating of this kind is rare [11], and even less likely given the fact that improving a peer's grade could harm mine grade. I certainly felt that the presumption was that I would cheat given the chance, and may very well need to given that he is going to such lengths to protect the questions?

- On two distinct occasions I noted how Dr. T engaged with student questions and was not able to give an answer that satisfied, why a student's work was incorrect. In both cases he just relied on "it is wrong, I know it" as an answer, seemingly expecting us to take the expert's word. In each instance I certainly felt that the student's line of questioning was fair, as I could not see the answer. There are times an expert 'knows' without being able to explain, yet it does not help novices learn. Instead of taking the issue offline or committing to look at it and come back, Dr. T let it drop. This discouraged me from pushing harder on questions at times as it made me feel the answer should be obvious. I feel had we taken the time to really understand the issue we may have really had an 'ah-ha!' moment, but instead I left still unsure, and less willing to engage.
- After the second test Dr. T stated, "I think that from the test that some people have memorized the book from the grading", which is confusing and accusatory at best. Did the people who memorized score well or poorly? We had not yet received the scores, and I now I was making it up as I went, so I did not know who had done what wrong and how it would impact my grade (remember, the rubric is not set publicly, nor till the end of the course). He followed with "There is no extra credit, so don't ask", which, I could have construed as "if I had not learned it by now I clearly was not capable" so you will likely fail. Thankfully I am a believer in the growth mindset, and the rubric seemed to work in my favor.

- The week the project was due Dr. T announced that we would be doing presentations the next week on the project. Since everyone did the same project, it was not entirely clear what we would be presenting, but we each created and presented same basic materials while giving each other scores, even though the scores were not part of the grade. At the very end of the last presentation Dr. T said, "I did the presentation, so I knew if you did the coding". The presentations apparently were a way to guard against collaboration or 'cheating'. At best, I felt tricked into busy work preparing a presentation, at worse I felt disrespected. It is easy to detect this form of plagiarism, having been a long-time programming instructor, and this seemed a backhanded way to validate academic honesty and a false hope at improving the grade.
- And perhaps the most baffling of all, the last week of class Dr. T announced: "Real life is different from what I did in the class". So what exactly did we learn? Are the skills I just spent hours and hours (partially) learning going to help me in the real world or not? Again, can I consider myself proficient in this field? I already know I struggled and underperformed, but now I may not even know things that are the authentic tasks I will be asked to perform?

This extensive list is not to impugn Dr. T or to demean the class, but to show how many seemingly small statements, policies, and decisions can undermine a student's self-efficacy. Also worth noting, I did not document, nor in reflection I can't remember, any specific instance of *building* self-efficacy. The traditional classroom does not typically facilitate opportunities to affirm self-efficacy in students, but could, by employing the rules from braves spaces, for example. Despite being who I am and the privileges I hold, most likely not really needing the class to graduate, and having a presumed rapport based on many conversations about teaching and learning, I did not feel confident nor comfortable in challenging, questioning, or even mentioning most of these occurrences. In this class, and others, I am reminded that I am a student being graded, and thus at a disadvantage when giving any feedback which could lead to repercussions. The ground rules of brave spaces could have been used to reminded Dr. T of his blind spots or at least given permission to seek explanation when they occur. As it stood, I chose to ignore many things that induced negative affect as the alternative was simply not worth the risk. Each 'diminishing statement' on its own likely could be explained away, but as a student already struggling, even for very explainable reasons, yet going to great lengths to put in the time and effort required to make progress, I felt I persisted despite the 'system' not because I was supported by it.

The testing rollercoaster

The best assessments model learning in authentic engineering tasks. In industry, engineers demonstrate conceptual knowledge through their project work, but authentic projects take time and are hard to recreate for novices in a typical testing periods. Industry work also it is typically collaborative and requires access to a variety resources, which are often prohibited in the classroom to ensure academic honesty. I have not had to take a traditional test in a long time, and will readily admit I have very little patience for them. I accept their (limited and occasional) value in the classroom, and thankfully having studied how people learn I understand ineffectiveness of cramming as genuinely want to know and master the content, not simply pass. Given the closed book, no resource nature of the tests, and a desire to use and teach this knowledge, I fully engaged in all available problem sets. I completed homework without guides, seeking assistance only to get me past sticking points. After grading, I reviewed the solution and

corrected my misunderstandings, even reworking problems before the test. I worked past tests the instructor posted (no answers), and even worked examples from the book as the nature of the subject meant there are not many sample problems even online. I feel I did all the things we tell students to do to learn, but the results left me disappointed and confused each time.

My emotional journey this semester was much like that in my undergraduate degree, unlike the non-engineering classes in any of my graduate work. My work in homework and feedback helped to grow my feelings of self-efficacy.

> *"I feel a solidifying grasp on the conceptual approaches to both apporaches, but certainly needed the detailed tweak of visiting the professor to solve" (September 22, 2017)*

I felt I was 'getting it' and visited the instructor for tips. I expected to struggle in homework getting simple feedback increased my confidence as I completed the few homework problems assigned. As the test approached however, I grew worried, as I felt I did not have enough practice options. Yes I wanted more homework! At the time I was reading a book about animal cognition and learning, and describe an example from the book describing how young chimps learn to crack nuts.

> *"Chimps will persist for 3 years before cracking their first nut, and 6 before they are proficient at it. [Their persistence] is likely due to social and cultural persistence rather than needing food* [18]. *This reminds me of watching the professor skip "the math" in class and solutions making it seem beneath our need to care as well." (September 27, 2017)*

I was feeling that the parts I struggled with, the math, was something the expert took for granted to the point that he did not bother to challenge us on it. He did not fully work examples in his notes, book, or even at times in class. Dr. T took it for granted that we all could flawless perform the math, and would see insights in the domain because the rules were present in the formulas, a task likely too much for novices. From my education background, I knew that I had to persist yet most students would not understand that expertise comes through hard work. Young chimps likely do not know why they are cracking nuts, and failing, day after day, but the social clues says that it is useful. By hiding away the hard work of 'working the math' Dr. T is removing opportunities to see how experts are made. Dr. T expressed an expert bind spot by excluding the hard work, rather than demonstrating it, even in a recorded media such as his book or notes. My metacognitive understanding of what it takes to become an expert was a double edged sword. I knew my math was weaker, "I had to 'relearn the math'" (October, 1, 2017), and I was not the only student with gaps in math skills: the instructor stated some students did not know the sin or cosine values for 0^2 on the second test. On one hand I knew what I needed to do to develop expertise, on the other hand I knew I was not getting enough of the practice I needed to build that expertise. I took the test with shaky confidence and left with mild optimism that I should at least receive strong partial credit for problems. The relief of finishing the test and not being completely incapable was hopeful, but being a novice with limited practice options I did not have any ability to assess how far I was away from true competency.

[2] They are 0 and 1 respectively, for those who may also not know.

The grading took about 10 days and the results were a blow. "I just feel disheartened" (October 7, 2017) and immediately started to consider ways to learn from my mistakes and gain perhaps gain back points for my grade.

> *"after a test the student is allowed to submit a write-up of 1.) what they did wrong, 2.) what the correct approach would have been and 3.) a consideration of what misconception drove their error and how they can fix it for next time." (October 7, 2017)*

I presented this suggestion to Dr. T who said it was too late as he already released the answer. Again, Dr. T shows a blind spot, as even when I saw the answer I it did not illuminate the concept. It shows what I did wrong in the moment (under a time crunch, without notes) but did not help me develop insight where my conceptual understanding failed so I could correct it for next time. And worse, there would be no next time, as the next test was all new material, so I had one chance to demonstrate competency for a grade.

The same pattern continued for the second test. I dove in even more fiercely, working each homework, looking at solutions afterward, working practice tests, visiting Dr. T on multiple occasions, and again felt insecure by the small number of practice options. The second test proved even more challenging as it covered a broader array of materials. We were provide as sample test with 4 questions across the two chapters being tested. I spent 12+ hours working the sample test to understanding these key concepts, yet the test in our class did not cover either of these problems, the core material of the chapter. Our test included four questions, the first two were variations on homework, and I felt confident, though likely took too much time as it took me longer to accurately complete and double check my math. The third question was a precursor skill we spent little time on and as such I neglected in order to spend time on the practice test. I felt this was 'fair' but felt I totally misunderstood what was important (as I studied the materials most appearing in the lecture, book, and practice test), or Dr. T expected we could flawlessly repeat a problem seen one time, and not included at all in his book. I was on the right track but ran out of time to finish and was severely graded down accordingly. The final question was never a homework problem but was a special set of slides presented because one of the homework problems we did work was 'wrong'.

The test approach was fair, and typical, and likely accurately assessed my learning at that point in time. It did little to promote the next step in learning, or I felt accurate reflect the ways I would authentically use this information. My test average was in the 50-60% range which was not actually bad for the class, with scores ranging from the 30s to the 90s. "It is quite simply disheartening and more so as I don't know of any path to recover" (November 26, 2017). I learned a lot from the tests, but had no chance to demonstrate that learning, as the grades were final. In the end I ended up with a B as the final grade and feel like I could teach the topics as I was taught but have no idea how I would use the concepts in industry. I know this professor is well respected in research and industrial applications, but by his own admission did not teach us how to apply this knowledge in the real world. In this case, most students are advanced seniors or graduate students, but if this class were a foundational engineering course, how likely would it be for the student to persist on to more advanced topics, when they did all they were asked yet still feel, as I do, they underperformed? Maybe I am rationalizing, but I am having a hard time finding fault in my approach or choices. I put in the effort, reached out for help when needed, followed up on mistakes, read the book, attended class, and failed to perform on tests. The

combination of Dr. T's fear of cheating and expert blind spot means practice and growth come second to assessment. When I was successful on homework, did I misinterpret my performance for real skill? Was the time and resource constrained test valid and I am at fault, or is it acceptable as a novice given enough time, notes, and/or computer support I can complete this task? Did I make the wrong choice in the first two weeks and not belong in the class to begin with? Even having passed the class, I struggle to feel I belonged, and succeeded.

Conclusions

Expert blind spots can play havoc on student emotions and self-efficacy, or at least at times they did for me. Self-efficacy governs not only the confidence to apply skills, but also the willingness and effort put into learning. My experience in returning to two traditional engineering classrooms supports the role of self-efficacy in learning. With Dr. A, I perfectly executed the work, but feel unsure about my level of competency. With Dr. T, I knew my skills and ego would be tested, and my 3.98 GPA was likely to suffer, but I was passionate (or pigheaded) enough to persist despite warning. I learned quite a bit from Dr. T and appreciate his knowledge, time and effort, but the structure of his classroom has challenged my self-efficacy. In interesting ways these two very different classrooms have had profound implications on the last years of my scholastic career.

One of the side reasons I wanted to take two EE courses was to evaluate my interest in pursuing an additional master's degree. After spending years in industry and my current master's degree in programming, I imagined reengaging with my undergraduate degree where I completed and enjoyed several graduate level classes in similar subjects. My prior success gives me the confidence to think I can succeed despite other 'rusty' skills. Taking these two classes has convinced me an additional master's degree is not worth my time. This is not to impugn the entire department or even these professors but is to say that I do not believe standard engineering pedagogy is a viable way for many non-traditional students like me to learn. Dr. A's course showed me that a concentrated self-study would do more to build skills in the areas needed. Dr. T showed me the value of a mentor to assist in learning, but how traditional assessment structures generally lack feedback for growth or information to authentic tasks. As I engage in what is likely my last semester of courses, I find the same thing in a course I am taking in the Computer Science department thus far, and the negative attitude lingers toward even my last non-engineering course. I started very much looking forward to taking every class I could fit into my schedule, and perhaps time, but I think more so 'the system' of the traditional classroom has diminished my willingness to learn in this paradigm. I do not write about this decision in any way to judge these classes or departments though, but to show you the ***power of emotion and self-efficacy in student learning***.

Self-efficacy and the associated emotions may be a powerful measure of and factor in determining student success. As a middle aged, well-employed, highly trained white male, I experienced many of the same stresses and concerns as would be described for any typical student. I was nervous to ask questions, unsure of my capabilities, did my best to cope with shortcomings. It seems, like many engineering students particularly underrepresented ones, I too have chosen to disengage from further traditional engineering education due to my experience. For me, I know I can learn this information more effectively in other ways, but for true novices, they may leave the field forever, not because of an inability to succeed overall, but because they were only given one narrow path to success. I hope in this paper I have provided

an analytical view of my experienced explained using theory, but more than that I hope that it sparks you to consider even the smallest decisions you make in planning classes, interacting with students, and how you perceive their actions and efforts.

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