

“HOW STUDENTS LEARN”

A Study in the Field of “Individual Behavior”

By **Prof. Alfred A. Scalza, P.E.**

Farmingdale State College

Department of Architecture and Construction Management

Abstract

Although the definition of learning and the theories of “how students learn” have been thoroughly studied, a new field has arisen in the study of “individual behavior” and how students who seem the same academically actually come to the first day of class with far differing personal credentials. Does “college ready” mean academically or should it also include socially and emotionally? All the students in their first day as freshmen, have been accepted to the university and have passed the entrance requirements whatever they may be. They have at least the minimum SAT score requirement and sometimes further requirements such as a portfolio. So why is it, four years later, about one third to one half of these students actually graduate?

Introduction / Objective

The objective of this paper is to investigate the hypothesis that although students pass the same entrance requirements, they pass them in different psychological vehicles. That is to say, their abilities actually differ. They may be traditional students or non-traditional students such as English language learners or returning adults. Abilities include, not only intelligence but also personality (enthusiasm, motivation), and psychological well-being. They also have differing biographical characteristics such as age/maturity (Case Study “A”), gender (Case Study “B”), culture (Case Study “C”). They therefore learn differently. These differences may require remedial classes to be college ready. They may need to re-learn the skills necessary for academic success. This paper is a look at how they come to the table of learning as well as how they learn. Abilities such as number aptitude, verbal comprehension, perception, inductive and deductive reasoning, and memory are all considered.

Basic Concepts / Learning

What is learning? It’s what we did when we went to school. That’s true but not the whole story. If we accept the fact that we are always in school, then the statement is true. We are always learning.

A better working definition might be as follows:

- Learning is any relatively permanent change in behavior that occurs as a result of experience¹. In other words, we infer that learning has taken place if an individual behaves, reacts, or responds as a result of experience in a manner different from the way he formerly behaved².

There are several components to learning that should be mentioned here. Learning involves change and change can be good or bad. We assume for this discussion that the change is for the good and that we expect our students to have some new and useful knowledge as a result of this learning experience. Secondly, learning should be ingrained. That is to say it should stick. Much of what we study and write about learning is based on how to receive the knowledge but more should be considered on how to insure retention and understanding of the knowledge. Thirdly, some form of experience is necessary to learn. That is why we in engineering do problems after imparting theory; to gain experience. Experience is the stimulus that makes the learning ingrained. Practice enhances retention and understanding.

Perhaps here I should digress and say something about the types of learners in our classrooms. Suffice to say that for the most part we have “active learners” and “passive learners”. This difference is the student’s mindset. Sadly, more and more students have come from high school with the mindset of a passive learner. High school teachers and administrators would agree that more and more regulations on how to teach and what to teach have created more and more passive learners. Also, the social environment the students learn in is often so time consuming and compelling that they easily fall into the passive category. Therefore, some effort is required by the professor to change this mindset to active learning and this takes time. Professors are tasked with the responsibility to re-teach students how to be self learners.

- **Passive Learners**

This is a philosophy that “expects” the faculty to teach them what they need to know to pass the course (and only what they need to know). They “expect” the library to have the article, journal or book when they need it and they wouldn’t consider reading something that wasn’t required reading for this course. They glance through assignments with minimal effort and investment “expecting” that the professor will provide a clear and exact summary of the material. After all, goes the thinking, why are they paying all of that money for tuition anyway? ³ Passive learners in my class have told me that they get the entire course from my lectures and seldom, if ever, read the book. This is a bad outcome since they are not learning to learn.

- **Active Learners**

The active learner comes to college with a more beneficial philosophy. Active learning is about students becoming agents in their own educational process. These students recognize their stake in the process. In fact, they take on activities, reading and other work with initiative and interest. They read with comprehension and annotation. They ask questions and “actively” seek more than just the basic requirements.³ Active learners seek understanding of the material and not just knowledge. Retention is much higher for active learners. These students tell me they understand the prerequisite requirements and how one course builds on the other. They like to cross pollinate from one course to the other. They are the students who are beginning to know what it means “to learn”.

Basic Theoretical Background / The Learning Theories

Now that we touched on the type of student learners, let us investigate three of the many learning theories as they apply to college students today. These theories are Classical Conditioning, Operant Conditioning and Social Learning. We will all recognize the learning patterns of our students in all three theories.

Classical Conditioning

Classical Conditioning grew out of experiments to teach dogs to salivate in response to the ringing of a bell, conducted in the early 1900's by Russian Psychologist Ivan Pavlov.⁴ This study connects an unconditioned stimulus to a conditioned stimulus and eventually to an unconditioned response. But students seldom learn as a response to a stimulus so this theory doesn't really apply to college learning.

Operant Conditioning

Operant Conditioning is much more applicable to students and their means of learning. Operant Conditioning states that the student's behavior is a function of its consequences. Students learn in order to get something they want (a good grade) or to avoid something they don't want (a failing grade). Therefore, this is voluntary or learned behavior not reflexive or unlearned behavior. Student learning depends on consequences and reinforcement. The reinforcement strengthens the behavior and increases the likelihood of this behavior being repeated. College students learn this way.

Social Learning

Students can also learn by observing what happens to other people and just by being told about something, as well as by direct experience. Students watch and learn from parents, teachers, peers, media, etc. This learning through observation is called social learning.⁵ This is the first theory to credit observation and perception as a teaching tool. Our students react to how they perceive the consequences not the consequences themselves. This is a two sided coin. Students learn from and imitate those they learn from. This could be the engineering professor they admire or a rock star. Sometimes social learning takes them to imitation of media people and events that are not conducive to college level learning. This is a very powerful tool since students are very susceptible to peer pressure.

Abilities

A common textbook definition of "ability" is the student's capacity to perform a task. This task may be physical (sports) or intellectual but for this discussion we mean intellectual. Student's intellectual ability is enhanced by that student's personality, enthusiasm, motivation and psychological well-being. Intellectual abilities are those needed to perform mental activities such as thinking, reasoning and problem solving.

In society, we place high value on intellectual ability. Smart people get better grades, earn more money in a lifetime, are more likely to be leaders instead of followers, therefore we measure intelligence quotient (IQ). Exams such as SAT, GMAT, LSAT and MSAT are all geared to measure IQ.⁶

There are numerous dimensions to measuring intelligence but the main ones relative to college students are as follows:

- Number Aptitude: ability to do speedy and accurate arithmetic. We can easily measure this ability and it is directly assessed in their Math classes.
- Verbal Comprehension: Ability to understand what is read or heard. Again we can and do measure this and we see its results in many classes starting with English class.
- Perceptual Speed: Ability to identify visual similarities or differences. This is harder to measure but we can measure it. Psychology and Sociology classes measure this.
- Inductive/Deductive Reasoning: Ability to identify a logical sequence and assess its implications. We see this in Math and Engineering classes.
- Spatial Visualization: Ability to imagine an object and its position in space. This feeds into their drafting and graphics (CADD) classes.
- Memory: Ability to retain and recall.
- Students with high aptitude in these dimensions tend to be better students. They also tend to be more creative students and are more adaptable to new things. They, simply put, “get it quickly”. They are usually more complex personalities with a more active lifestyle and many varied interests.

Having said all of the above, intelligence doesn’t make people happy or more satisfied. It doesn’t mean they are automatically enthusiastic or motivated. It is true that smart people (students) have it generally better but they also expect more.⁷ Students of high IQ ability can find themselves easily bored. Generally speaking, intelligence may be better understood in its parts.

The Four Parts of Intelligence

- Cognitive Intelligence: traditional IQ type intelligence. This is easily measured but truly not the whole story.
- Social Intelligence: the ability to interact with others; mostly a component of personality. The student’s level of enthusiasm and motivation are related to his social intelligence. Easily seen on a day to day basis but hard to measure.
- Emotional Intelligence: ability to identify, understand and manage emotions; another component of personality. This is a very complex issue which we have just started to try to measure with EQ testing.
- Cultural Intelligence: an awareness of cross-cultural differences. In our global society, this has become more and more important but it remains difficult to measure.

More and more, we are trying to understand our students and their abilities to learn in these four categories but measuring all but cognitive intelligence has remained allusive⁸

Generally, we know, after years of study of cognition, motivation and human development, the following four key concepts that apply to college students:

1. Knowledge is constructed, not received. We, at first, thought a student had to receive information, store it, and then understand it. Today, most teachers believe that knowledge is constructed as it is received and understanding of the material happens at the same time as storage of the material. Understanding is the key to retention and self-learning is the key to understanding. Professors are finding themselves more a mentor than a lecturer.
2. Mental models change slowly. It is our intention to challenge the existing mental models our students hold in order to facilitate deep learning instead of surface learning. "Deep learning is understanding" whereas "surface learning is remembering the material long enough to pass the next exam." Student-centered learning is beginning to recognize this and professors are being forced to change how they conduct their classes.
3. Student questions are critical. Most professors agree that students learn better after asking questions. Students should be encouraged to ask questions in class and out. Some cognitive scientists think that questions are so important that we cannot learn until the right question has been asked: if memory does not ask the question, it will not know where to index the answer⁹. Student-centered learning facilitates students asking questions of the professor and other students. Students get some of their most crucial learning from their peers.
4. Caring is critical. Professors must make their students care. If they don't care, they will not try to reconcile, explain, modify or integrate new knowledge into the old.⁹ If they don't care, they will "learn" enough to pass the course and actually "learn" nothing since they will have retained or understood nothing.

Biographical Characteristics / Statistical Significance

I have gathered data over a period of 13 years (1996 to 2009), looking at biographical characteristics that separate students from one another. All of the classes are in the category of either Construction Management or Civil Engineering. Our Architecture students take these classes as required courses.

The significance of the data is easily quantifiable. Over a period of 13 years from 1996 to 2009 I have kept grading sheets for the classes I taught in Construction Management and Civil Engineering. There were 48 classes averaging 25 students per class. Overall, I compiled a record of the grading trends of 1148 students. As a full time professor I see approximately 80 students per semester (4 classes of 25 students each but some are in more than one class). Farmingdale State College enrollment has risen from 5045 in the year 2000 to 6988 students in the year 2009. The School of Engineering Technology has grown from 842 to 997. Our own curriculum, Architecture and Construction Management, has grown from 133 in the year 2000 to 276 in the year 2009. In fact we grew at a steady rate up to 286 in 2007 and then leveled off and retreated to 276. On average, in that period I saw 80 students out of 205 average enrollment so

my sample size is significant for our curriculum and even for the School of Engineering. That is to say, my sample size is about 80 out of 205 or 39% of our curriculum. The sample size is not small although it is specialized. All the students are in the curriculums of Architecture or Construction Management. Still, I believe the trends are significant and reasonably typical for the entire School of Engineering Technology.

In Case Study “A” where maturity is the variable, I must say each student was placed in a 5 year category by me and statistics kept that way. I did conclude that this distinction is lessening as more older students take day classes (a result of the bad economy) and more young students take night classes (they prefer to work if they can).

In Case Study “B” the variable is gender. Here the sample size is small. My classes average only 5 female students to 20 male students. There appears to be no other distinctions of interest. I believe this trend is typical but reversed in the School of Nursing.

In Case Study “C” the variable is cultural background. I placed the students in the cultural categories without discussion with the students. The trend was interesting. The student’s class averages converged as the four year program progressed. The averages were clearly further apart after year one and converged to almost no difference by the end of year four. The trend was easily discernable.

Case Study “A”, Maturity

We will for the purpose of this paper make the assumption that age and maturity coincide. Also, as much as I would like, I was not able to discern actual ages (it would have been discriminatory to ask) but instead placed each student in a 5 year age bracket. For example, evening students had more in the “over 30 bracket” than day students.

At Farmingdale State College we teach courses from 8 AM to 10 PM without the distinction of day school or night school. However, the night classes tend to have older students usually working in the daytime and often married. They are generally more mature than day school students who tend to come directly from high school and are younger and less mature. This line is blurring since more students tend to come to us as transfer students from another college. There have been numerous studies on this aspect and the general perception is not clear¹⁰ For example; when it comes to workers in different industries, it is unclear whether older workers are better workers although in certain industries the results favor the older worker. Some of the criteria such as attendance do clearly favor the older worker. For students in college, it appears to be very clear that the older students are more mature and bring a better attitude towards their studies. The older students have different outside pressures but handle these pressures better. The older students have more desire for the material and less for the social activities than the younger students.

Case Study “A” is a comparison of day school students and night school students. Every spring semester I teach two sections of the same engineering course, Elements of Strength of Materials. One section is in the daytime and one in the evening. I teach these two sections exactly the same and use all the same materials except the exams.

- The results are interesting and do seem to correlate with maturity.
- The day students (younger) have higher absenteeism. They average 2 absences per student per semester compared to 1.5 per student per semester for the night students.
- They tend to show up late more often and by greater amounts of time. Their tardiness averages 2.66 per student compared to 1.05 per student in the evening.
- Their average grades tend to be lower too. The day class averages 68.42 compared to 69.96 for the evening class.
- They tend not to do any additional work for homework other than the assigned problems and then only those which they know I will collect. When I collect random problems they play “homework roulette”.
- The level and amount of cheating is higher in the day class compared to the night (older) students.
- The night students come early, stay late and want to talk about the subject.
- The day students sometimes leave at break time and are usually not interested in anything additional.
- They are typical passive learners. This is not true of all the day students but describes a high percentage. I believe this behavior is directly related to maturity. The older, more mature students are in the industry and want to share their experiences with the teacher and the rest of the class. This makes for a better flowing class discussion.
- I have confidence in these findings since I have witnessed this between day and night classes over a period of 13 years and the results are fairly consistent. However, more young students are opting for night classes so they can work and so the lines are blurring. The distinctions between the two are less clear every year.

Case Study “B”, Gender

Case Study “B” is a running comparison over 13 years showing grades broken down by gender. This is an interesting observation since it applies to both the young daytime students and the older nighttime students. Our curriculum is Architectural Engineering Technology and Construction Management Engineering Technology, currently a male dominated profession, and our classes are predominantly male. The ratio is usually five female students in a class of 25 students. One statistical distinction is 90% of the women students are in the Architecture curriculum. The male students are 40% in Architecture and 60% in Construction Management. The women, whether in the day class or the evening class, far outpace the men. They work harder, pay more attention, do more work, show more interest, and usually find time to be involved in our various professional clubs. The grade differential is substantial.

- The average grade for female students is 75.536 while their male counterparts have an average grade of 71.301. No other comparison that I have run has such a large differential.
- Another phenomenon of interest concerning gender is “leadership”. The women in the class do not seek the leadership role but instead seek the teacher or tutor role. Most time, when a group is working together, it’s the woman who is tutoring the males in the group.
- In one of our Construction Management classes, we require a group research paper with an oral presentation and defense of the paper. Historically, the best papers, best oral presentation and best defense have always been the group with female members.

Case Study “C”, Culture

Cultural differences are much more difficult to study and I hope no one takes offense at my trying. Cultural differences appear to come into play not as a difference in intelligence but instead as a difference in perception of intelligence and attitudes of both the students and the professors. Case Study “C” is a 13 year look at grades and motivation based on culture. The social environment of the classroom is particularly important to the social aspects of learning. A student’s self perception is often included in that student’s ability to learn. Some students have a distinct ability to relate to other students of different cultures. In fact, scientist believe, this is an attribute called “cultural intelligence” which may turn out to be more important as we become more and more a global society. Some people have a natural instinct to interpret gestures and behaviors of other cultures. I believe the students are far ahead of the professors on this item.

The data here is substantial in volume (over 13 years) but volume only. This data must be tempered by the fact that each student was placed in a category by myself without discussion with the student. I am sure that the precision of my choosing categories and placing students in them is somewhat flawed. Nevertheless, I wanted to look at student grades from every possible angle since I am very interested in how we assess our students. For example, do our exams actually measure how much the student knows? I sometimes wonder. Are our exams even “fair” to all cultures and does language play an important role in student’s understanding of the exam questions and how they answer? Over the years my categories have expanded. It must be understood that this cast no aspersions or credit to any culture and may not be true across other curriculums. In fact, it may say more about how we assess our students and how they come prepared to be “college ready” when they arrive.

<u>Cultural Background</u>	<u>Average Grade</u>
American/European	71.804
Hispanic	71.786
African American	70.591
Middle-East	70.969
East Indian	72.501
Far East	73.101

Some interesting trends showed up throughout this study. The Far Eastern students started out further ahead but their average came back to the class average as they were longer in our system and curriculum. In my opinion, this was quite significant. The one half point gap between the Far East students and the East Indian students is more like one and one half percent if only the first two years are considered.

The African American students faired better as they were longer in the system; perhaps a result of less influence from high school and more influence at college. That begs the question, “do all high schools prepare their students for college readiness the same?” The answer would appear to be “NO” but that’s an issue for another paper.

As in any study, the observer is reluctantly part of the study. The results are those of only one professor (myself) and, as with all observers, I see students through my own cultural filter which I'm sure would vary from observer to observer. Because of my affinity for the students, I hope this distortion has been minimized.

In one of our Construction Management classes where "ethics" is an important topic, the more diverse the group the better understanding of "ethics". In fact, the more diverse the group the more passion and fervor to the "ethics" discussion. Clearly, diversification in the classroom makes for an enhanced discussion. In fact, the students bring up issues for discussion that the professor hadn't thought of and discussing their issues is what class should be about. The professor is a moderator more than a lecturer.

Synopsis

We have looked at "learning" and the "types of learners" (active vs. passive) and must concede that our classroom has both types. We talked of "learning theories", "abilities", the "parts of intelligence" and the "biographical characteristics" of the students. Again our classroom runs the full range of these so what is the predominant mechanism we are using to teach our students. Maybe more important is how do we get them to teach themselves since student centered learning leads to more and better retention.

All the above is under the "behaviorism" umbrella. Behaviorism is a theory which argues student's behavior follows stimuli in a relatively unthinking manner. But students do think. They learn mostly through the part of behaviorism called "social learning". Social learning is an extension of operant conditioning which is to say learning is a function of consequences. This leads us to the theory used in business and academia called "shaping behavior".

Shaping Behavior

"Shaping Behavior" is a systematic reinforcing of each successive step that takes the student closer to the desired response. This is an attempt to mold students by guiding their learning in graduated steps eventually taking them to "student centered or self learning". There are four means to shape behavior, all used in the classroom to some extent.

1. "Positive Reinforcement". This happens when the teacher follows an action with something pleasant. For example; praising a student for home work well done, for a good answer in class, or for a particularly insightful paper. I list positive reinforcement first because it is the most powerful in the long run.
2. "Negative Reinforcement". This is when the teacher might follow a response from a student by the termination or withdrawal of something unpleasant to that student. For example; the teacher asks a question, the student answers it well but is uncomfortable, so the teacher calls on that student less often.
3. "Punishment" is causing an unpleasant condition in order to eliminate an undesirable behavior. Giving a student a bad grade on his home work because it is in the wrong format (even though it may be correct) is an example of punishment to shape behavior.

4. “Extinction” is eliminating any reinforcement that is maintaining a behavior. When the teacher does not provide any reinforcement for a behavior, it slowly disappears. For example; the teacher wants to discourage students from asking questions during the lecture so he ignores the up-raised hands and gradually, no one will raise their hand to ask a question.

Of these techniques, the first two, positive and negative reinforcement result in learning taking place. They add to the response strength and increase the probability of the good response happening and happening more frequently. The teacher, like the parent, has a powerful weapon in the form of “praise”. All humans desire to be praised and students respond to praise with greater quantity and higher quality work.

The last two techniques “punishment” and “extinction” actually weaken behavior and lessen the probability of getting from the student the type of positive responses that the professor might want.

The question then becomes, “what is the timing and strength of the reinforcement required for the output we want to achieve?” We should use all the following to reinforce our students where appropriate.

- “Continuous reinforcement” might be in the form of praise after each desired response. This will lead to fast learning of the new behavior but sometimes leads to equally fast extinction of this behavior. Also, it may lose its potency if over used. Eventually, as the intermediate steps are learned, the professor should start taking some response as “expected” responses now that we have moved this far down the path.
- “Fixed-interval reinforcement” is a reinforcement given at fixed periods of time. This might be in the form of a weekly quiz. Those with positive results are positively reinforced. I like this weekly reinforcement but it too loses its potency as the semester goes on.
- “Variable-interval reinforcement” is a reinforcement given at variable times such as a pop quiz given at varying intervals. This has a feeling somewhere between a weekly quiz and a full exam so it covers more material, has higher reinforcement value and slower extinction value.
- “fixed or variable ratio reinforcement” are rewards given for various amounts and quality of output. This causes high performance with slow extinction. This is our grading system. It’s a great tool for reinforcement so our means of assessment are critical. Nothing loses a student quicker and with more damage than the student feeling he has been given an unfair grade. Now I know almost all students feel almost all of the time that their grade should have been higher. That’s not the question here; this is a student who genuinely believes his or her grade was UNFAIR.

Conclusions

- The students coming into college, either as new freshman or as transfer students, come in with different levels of ability and it’s not just intellectual ability (IQ).
- I have concluded after several years of running parallel sections that age (maturity), gender and cultural differences affect the ability quotient that the student brings to class.
- Case Study “A”, based on maturity, indicates that maturity should be built into our measurements of ability since my limited case study showed it mattered. Maybe age and

work experience should be somehow included in the entrance requirements. Perhaps a potential student should be required to write a paper about his work experiences to show his level of maturity.

- Case Study “B”, based on gender, shows a difference between genders but this might be discriminatory to consider this as an entrance requirement. Suffice to say, we should start encouraging students of the minority gender to take curriculums that are predominantly the other gender. Eventually, no career should be naturally male or female dominated.
- Case Study “C”, based on cultural differences, indicates that although students of different cultures start differently, they end up with little to no real difference in how they learn. Maybe, as they mature the slight differences disappear.
- We must build into the admission exams, a test to measure emotional quotient (EQ) and must understand the emotional differences between the incoming students.
- Perhaps someday we will have the means to measure all of the ability quotients.
- Remember the early studies about visual learners, audio learners and tactile/kinesthetic learners and how we felt students learned differently. One thing everyone agreed was that the better college students were mixed modality learners. It takes all three modes of learning to be a successful college student. Also, it would appear that mixed modality means more than visual, audio and tactile/kinesthetic. Mixed modality must include maturity, gender and culture.
- We are “shaping” our student’s ability to learn as well as “what they learn” so we must take a hard look at the use of reinforcement and the quality of assessment.

Bibliography:

1. H.M. Weiss, *Learning Theory and Industrial and Organizational Psychology*, Consulting Psychologists Press, Palo Alto, CA, 1990
2. W. McGhee, *Are We Using What We Know About Training, Learning Theory and Training*, Personal Psychology, New York, 1958
3. L.L. Hazard, J.P. Nadeau, *Foundations for Learning*, Pearson-Prentice Hall Publisher, Second Edition, Columbus, OH, 2009
4. I.P. Pavlov, *The Work of the Digestive Glands*, Charles Griffin Publisher, London, England, 1902
5. A. Bandura, *Social Learning Theory*, Prentice Hall Publication, Upper Saddle River, NJ, 1977
6. L.S. Gottresdson, *The Challenge and Promise of Cognitive Career Assessment*, Journal of Career Assessment, New York, 2003
7. Y. Gansack, *Intelligence and Job Satisfaction*, Academy of Management Journal, New York, 2003
8. D. Lubinski, C.P. Benbow, *An Opportunity for Empiricism*, PsycCRITIQUES, 2004
9. K. Bain, *What the Best College Teachers Do*, Harvard University Press, Cambridge, MA, 2004
10. S.R. Rhodes, *Age Related Differences in Work Attitudes and Behavior*, Psychological Bulletin, 1983