IST
School of Information Sciences and Technology

Problem Based Learning: Lead to Learn, Learn to Lead.

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Section 1: Introducing Problem Based Learning

Problem based learning – or PBL as we call it – is based on research in the cognitive sciences on how we learn. PBL improves learning. It is one of the big success stories in education in the last decades. You are lucky to be in a PBL course, but it will challenge your habits. If you are like most students you will come to prefer this new way. This manual will help you set aside old ways of learning and give you some tips on how to develop new ways. The first tip is watch what you are doing when you learn – whether you are learning in this course or in your residence hall -- whether on the web or in the gym. Notice when learning is fun and rewarding. Notice when it seems to be a chore.

The simple revolutionary idea that problems should come before answers drives PBL. Beginning with a problem puts you in the driver's seat. You can use your previous knowledge, your hunches, and your wildest ideas to try for a solution. In the process you can develop an inventory of what you know and what you need to know to get to a solution. Once you know that you can start questioning your instructor or your classmates, plundering the library, surfing the net, or bugging the many excellent Penn State experts to fill your needs.

In the last thirty years we have discovered more about how people learn than in the rest of human history. Much of the knowledge resulted from the invention of computers. Computers have provided new ways of thinking about computation, memory, and perception. In some ways the human brain is like a computer but in important other ways it is not. The brain is a "computer" that is wet, emotional, self-programming and far, far more powerful and flexible than any device ever built.

The good news is that this new knowledge contains ideas on how to make learning more effective and more efficient for students. The bad news is that what we usually do in classrooms contradicts those ideas. As a result, trying to become a good student means acquiring learning habits that promote poor memory, practicality, and creativity. Worst of all we lose the joy and excitement of learning. Since we are all humans who learn all of the time, we have other habits of learning we use outside of school that promote long term memory, easy transfer to other situations and many new ideas. Now, your job is to

reduce the bad habits (memorize stuff to regurgitate on tests) and promote the good ones (start with what you know, try it out, and improve).

Why is how you learn important? If you read papers and magazines or watch television it appears that our educational system is a disaster. That is not exactly true. Today the world of work, citizenship, and daily tasks require more knowledge and thinking skills than ever. The days of going to work and having someone tell you what to do are disappearing fast. We call our times the age of information. It means that we all need to be experts, leaders, managers, creators, and innovators. The necessary knowledge to do these things changes rapidly. What you will learn in college quickly will be obsolete when you graduate. As a result, you must prepare to learn throughout your lifetime.

Political issues concerning the Internet, social security, education, and defense require sophisticated citizen understanding. We need to know what information to seek and what positions to support. No longer can we decide such issues the way our parents would or according to some party or ideology. Purchasing everything from communication and computing devices to cars, homes and air travel requires knowledge. We need to know our own needs, the range of options and costs in time and money. Deciding on what work to do, where to live, what kind of a family to have all require extensive knowledge. Again, that knowledge changes rapidly.

> Chris Galvin, CEO of Motorola says, "Motorola no longer wants to hire engineers with a four-year degree, we need our employees to have a 40-year degree."

One of the major reasons that you and your parents are paying for a college education is so you will have a more interesting and fulfilling life. Such a life has challenging jobs, better income (which allows you to live in good communities, to have comfortable surroundings, to travel, and to enjoy hobbies), and the ability to think and communicate that makes a difference in the safety, prosperity, and freedom of your community.

To get and hold a good job according to leading companies requires that you be able to do seven basic things:

- Learn to learn
- Communicate and collaborate with others
- Think creatively to solve novel problems
- Be technically competent
- Understand the opportunities and constraints of the global economy
- Lead as well as follow, always taking initiative
- Manage your career to develop new skills and knowledge.

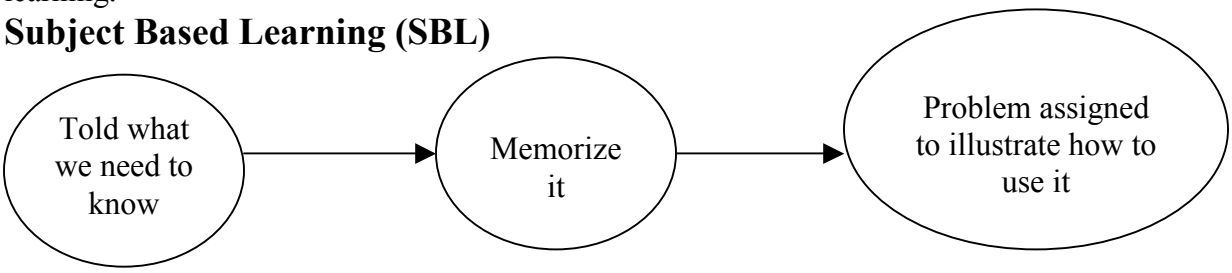
What is wrong with the old teacher-stand-up-and-talk-student-sit-and-listen learning? It doesn't meet the needs. It is too slow, too shallow, too inefficient and not much fun. Students retain little of what they learn after even a few weeks. Students rarely can apply

what they have learned to the unpredictable problems of life and work. Students get little practice in thinking for themselves or framing problems that interest them. As a result, students come to see learning as something grim to be avoided.

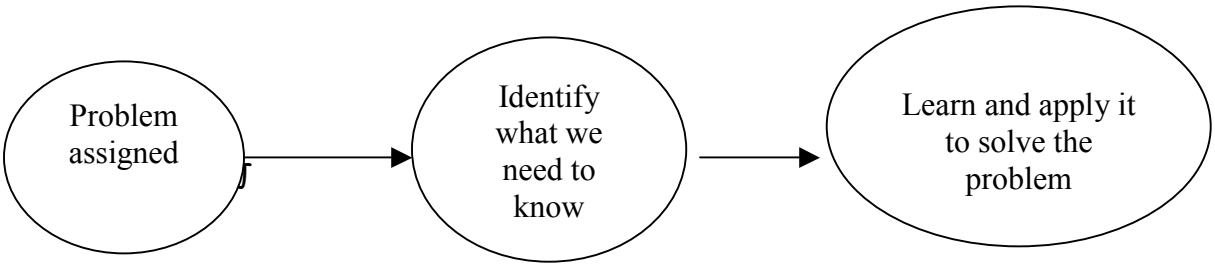
Problem based learning gives you opportunities to examine and try out what you already know; discover what you need to learn; develop your people skills for achieving higher performance in teams; improve your writing and speaking abilities, to state and defend with sound arguments and evidence your own ideas; and to become more flexible in your approach to problems that surprise and dismay others. Despite the work and effort it requires, PBL is never dull and is often fun.

Here is a diagram of the basic difference between subject based and problem based learning.

Subject Based Learning (SBL)



Problem Based Learning (PBL)



Student Joe B. Cool asks, "You mean in this course we have to figure out what we need to know and then help each other learn it? That's the teacher's job, not mine."

Instructor Stone R. Cold replies, "Yes, that is just what it means. My job is to design the problems, select resources, help you manage your learning, be your coach, and constantly strive to make the process better. Your job is to learn. Can you agree to that?"

Section 2: Problem Solving

Problem solving is not the same as doing an exercise. In "exercise solving" we recall and apply past routines. We work forward from the past to the solution. Usually there is one right answer. In "problem solving" we begin unsure about how to proceed and what new knowledge we need for a solution. We work backwards by starting with a plausible solution and then search for the necessary knowledge to support it, change it, and apply it. There is no single right answer, but better and worse solutions. Solving problems is more difficult. The good news is you have been doing it for years. Your first task is think about how you go about solving problems like buying a car, choosing a major, or getting your roommate to pick up clothes. Jot down some of the steps you took and then read on.

There are many ways to solve problems and lots of experts to tell you how. Nearly all of them agree that groups can solve problems better than individuals if they plan and take certain steps. This outline will introduce you to the basics. For more ideas and details read chapter 11 in your Speech Communication textbook, *Effective Group Discussion.*

Step 1: Explore the issues. What do I already know and believe about this topic and how can I share that with my teammates?

Suppose you have been assigned the problem: "Do computers improve learning?" Everyone on your team probably has experience with computers in classrooms, has read articles, and heard opinions. What is the best way to get that information at everyone's disposal? One time-honored method is tell each other stories about your experiences – what you have seen, what you have done, and what you have heard. Taking the time to do that will give you a good foundation to take the next step. Besides, telling stories is fun and it is a prime skill in an information-saturated world. Stories organize information and knowledge in forms that are easy to remember and easy to adapt and apply to new experiences.

Step 2: Define the problem. What do I think is the problem we have to solve and how can my team agree on a problem statement?

Defining the problem requires much discussion and inquiry. The goal is to understand the problem and create rich mental images of the situation that includes the conditions, constraints, and criteria of an acceptable solution. (Send your problem statement to the instructor to see if you are on the right track.)

If you are assigned the question: "Do computers improve learning?" you can see that there are many different ways to frame the problem in the question. You might conclude that the problem is research – A) "What studies have been done about student learning improvement when they use computers and what do they tell us?" You might decide that the issues are more complicated by taking the question as a hypothesis – a possibly true generalization. Then the problem is: B) "Is this a reasonable hypothesis that is worth the time and cost to test?"

Step 3: Investigate solutions. What do we have to know and do to solve this problem? This step requires much discussion. Play around with the problem statement and your knowledge and experience. Search for links, uncover assumptions, and identify what your team knows and what it needs to know. Make sure you agree on a solution.

- *If the problem above were A) for example, you might need to review the research to find the latest and most comprehensive studies concerning computers and learning. You would need to discover what kinds of studies have been done, estimate their reliability (which might take you on a side-trip in statistics), and judge what you can infer from the cumulative evidence.*
- *If the problem were B) you might look for theories of learning that support or debunk the hypothesis and indicate whether it is worth investigating. You would be asking: What do we know about how people learn and does that suggest that computers could help?*

Step 4: Research the knowledge and data that supports your solution. Your team needs to plan the work, assign tasks, and set deadlines.

- *Discuss possible resources: A) course sources such as textbooks, lectures, and instructor supplied citations and suggestions, B) library sources (ask a librarian for help in locating the best sources and search strategies, and C) web sources (web sites are easy to access, but they are risky because they differ greatly in reliability. You have to discriminate between the sites of experts and sites like "Ralph's pretty good solutions." (When in doubt about reliability, ask the instructor.)*
- *Schedule assigned tasks, setting deadlines that allow you time for each team member to teach others about their findings.*
- *If your solution seems well supported and you can create a compelling argument for it, proceed to the next step. If not, re-do steps 3 and 4.*

Step 5: Write your solution and submit. Use your best communication skills to state your solution clearly and support it with relevant arguments and evidence. Leave enough time for reviews of organization, lively writing and proofreading. Don't mess up good thinking and research with a sloppy presentation.

Step 6: Review your performance. This step is easy to overlook, but it is crucial to improving your problem-solving skills. When you get an evaluation of your solution go over it individually and as a team to see what you did well and what mistakes you made. Mistakes are opportunities for learning. Discuss them to plan improvements on the next problem.

Section 3. Arguments – a fast introduction.

> *Doreen considered her classmate's answer, and then said, "I don't believe that."*
> *"Why don't you believe that?" Professor Sam Minion asked.*
> *"I just don't", she replied.*
> *"Look," the professor said patiently, "you can't just say that. You have to make an argument."*

"Ok," said Doreen. She turned to the classmate. Looked in to his eyes and declared, "You are stupid!"
Professor Minion smacked himself on the head and began to weep. "No, no, no," he moaned that isn't what I meant.

Like many, Doreen thought that an argument meant a fight, an exchange of insults or a shouting match. "My parents had another argument last night," meant that there was a verbal battle. One dictionary definition of "argument" is "disputation" or battle. As such arguments may be noisy and pointless.

In problem solving, the term "argument" has a technical meaning. To make an argument is to offer a set of reasons or evidence in support of a conclusion. An argument is not a statement of opinion, but an attempt to support opinions or assertions with reasons. Arguments in this sense are essential tools of intellectual inquiry. They are ways of seeking truth by comparing the quality of evidence that supports conclusions. If we can't support our conclusion with better and stronger arguments we must change them to remain reasonable. Arguments are the intellectual equivalent of a Darwinian struggle for survival. Weak arguments lead to dropped conclusions. Strong arguments enforce our acceptance of conclusions.

If an argument offers reasons and evidence that support a conclusion that allows others to make up their own minds. If you believe a conclusion such as, "Computers drastically improve learning," offer others the reasons, the data, and the information that convinced you. Such arguments open a discussion in which we can learn from each other and improve the quality of our knowledge. There is nothing wrong with reaching a conclusion and stating it in the boldest terms if you supply the reasons that persuaded you. The mistake is to state conclusions only. That stops discussion, learning and improvement.

Here are some basic forms of arguments to get you started:

1. **Categorical arguments** make the case that something, an X, is a member of a category, Y. You observe a small gray furry animal with a long hairless tail in the kitchen. That description, while accurate, does not help you do anything. But if that animal is a member of the category, mice, you can anticipate what it will eat, how it will act, and whether its presence in your kitchen requires some action.

The conclusion, "There is a mouse in the kitchen," requires an argument that runs:

Premise 1: (The definition of the category) Mice are small furry animals that live in an about human dwellings, feeding on food stocks and wastage often gnawing through walls and damage bed clothes. They are 2 to 5 inches in length, of gray color, with pointed snouts, sharp teeth, furry bodies and long hairless tails of 1 to 3 inches.
Premise 2: (The diagnosis) The animal in the kitchen is about 3 inches long, gray, furry and with a hairless tail 2 inches long.
Therefore: There is a mouse in the kitchen.

2. **Predictive arguments** make a case for anticipating events based on the characteristics of a category. Once you have identified an animal as a mouse then you can anticipate what it will do based on the general knowledge of the classification, "mice."

The conclusion: "That mouse in the kitchen will damage the pantry, if we don't trap it," requires an argument of the form:

Premise 1: Mice are small furry animals that live in an about human dwellings, feeding on food stocks and wastage often gnawing through walls and damage bed clothes.
Premise 2: There is a mouse in the kitchen
Therefore : That mouse in the kitchen will damage the pantry, if we don't trap it.

3. **Change arguments** make a case that something has happened based on the comparison of two or more observations made a different times. You must create two descriptions of the same thing at different times and note any differences.

The conclusion: "The cheese is gone," requires an argument of the form:

Premise 1: There was a piece of sharp cheddar cheese on the table when I went to bed.
Premise 2: There was no cheese on the table when I got up.
Therefore: The cheese is gone.

While these examples are too simple to usually need expression, when it comes to talking about complex concepts like organizations, networks, interfaces, societies, nation states, etc. conclusions require justification by arguments of these types. If I want to make the case that this university is becoming obsolete, for example, I will need to make a change argument. If I want to make the case that businesses are actually for-profit universities, I need to make a categorical argument. If I want to predict that Penn State will continue to expand in enrollment through 2020 part of my case will be a predictive argument.

Section 4: Tips on Organization

"What do I have to do to get an A?"
That is the worst question you can ask on a PBL assignment. There is no one right answer when you have to frame a problem and solve it, because it is your problem and your solution. If follows that you have come up with a plan of organization that presents your work in an interesting and compelling way.

After you have brainstormed, read, researched and put together a pile of information and data, how do you turn that into a report that will have impact on your readers or audience? There are many ways to do it. The main thing is to pick a way and to stick to it. Here are some tips on organization to get you started.

Problem based presentations requires four basic parts: 1) a statement of the problem; 2) a statement of the proposed solution; 3) supporting arguments; and, usually, 4) a conclusion. The model is:

PROBLEM STATEMENT	SOLUTION STATEMENT	ARGUMENTS 1, 2, ...n	CONCLUSION

Introducing your presentation with a startling, whimsical or compelling statement of the problem (and maybe the solution) will get your reader's attention. For example:

"In room 102 of Asbury High School 47 sit dusty Macintosh computers waiting for someone to think different and turn them on. The principle, Joe McCrea, talks about them, but students seldom use them, because their teachers don't encourage it."

You could follow that introduction with a statement of the problem:

"Computers have little on no impact on most high school students' learning because teachers don't know how to use them properly."

Then state your solution. What follows is an argumentative essay in which you present arguments and evidence that supports your diagnosis of the problem and your proposed solution. Such an essay elaborates an argument or offers a series of arguments held together by a design. The design is up to you.

Some teams may start with an outline, others with a set of points they want to make, and still others with a story they want to build on. Make sure you stay within the design by testing every paragraph with the questions – what does it say and what does it do for the design of the essay? Drop or re-write the paragraphs that don't fit the design and further your argument.

Section 5 -- Where's your evidence?

"Look!" Charley told the English professor, "This is an information age. We should be learning how to judge the reliability of all these claims and not be spitting back to you what Hamlet said to what's-her-name."
"What's your evidence?" asked the professor.
"It's all around you," Charley cried. "Can't you see it?"
"I still want <u>your</u> evidence," the professor insisted.
"I'm not a scientist. I know what I believe. I'm not going to go get you a bunch of numbers and citations. If you won't listen to my opinions. How can we have a discussion?" Charley said and walked away.

What could Charley gain from offering evidence? He would make a discussion possible and he might learn something. For if we offer our opinions and claims without evidence, the only discussion we can have is about our character. Saying, "I believe, I declare, I claim, I know, It's my opinion," forces others to focus on you, your appearance, and your personality instead of your ideas.

When students work on solutions in a problem based course they have to discuss many conflicting opinions. They have to evaluate the claims and counter-claims of people working in IT. The point is to learn the details, terms, and principles used by practicing experts while gaining skills of communication, cooperation and critical judgment. In such discussion the focus should be on claims and evidence, not personalities. Give me

your reasons and I can argue with you until we reach a solution. Give me your opinions only and we can only shout and fight.

How could Charley convince the professor? He could offer several kinds of evidence – examples (events, imaginary instances, analogies), authoritative testimony, and numbers (graphs, tables, or other statistics).

EXAMPLES: We use examples to point to observations that support our claim. Suppose we claim that Penn State will lose its football game to Michigan. We can cite real events – "Penn State lost to Pitt"; imaginary instances – "If this PSU team had the ball first and ten on their opponents five yard line, their best weapon would be to punt" or analogies – "Alabama began losing big games when another coaching legend, Bear Bryant, hung around too long."

Each type of example has its weakness and any example can be challenged. We have to show:

- that **real events** can be taken out of their context and applied – the defenses of Pitt and Michigan are alike
- that an **imaginary instance** illustrates the relevant details clearly – the specific weakness of the team is its offense. (note: illustrations aren't really evidence, but they are useful for clarifying and stressing the important issues in an argument.)
- that the different things in an **analogy** are similar in the point of the argument – legendary coaches grow more confident with successes even as they become less flexible and creative.

AUTHORITATIVE TESTIMONY: We cite or quote authorities to support our claim. Suppose we claim that binge drinking is declining at Penn State. We could supply a quote from President Spanier, cite the conclusion of a study completed by the office of residence life, or even refer to our own experience (sometimes we are an authority if we have been there and seen that).

Using authorities requires some caution. Be sure:

- the authority is an authority on the subject – Alan Greenspan is an authority, but not on the drinking habits of PSU students.
- the authority isn't biased – since President Spanier has declared his intentions of changing the public image of PSU as a party school maybe we can't trust his testimony.
- the authority has a name – anonymous experts, scientists, doctors, students, sports fans, are suspect.
- the authority is up to date – Joseph Heller (the author of the beloved *Catch 22*) can only testify on the PSU undergraduate life he saw in the 1950s.

NUMBERS: We use various kinds of quantitative data and statistics to illustrate the reliability of our claims. If we claim that Pennsylvania is a good place to live we could state the crimes rate for the last ten years and present that in a graphic form to show that

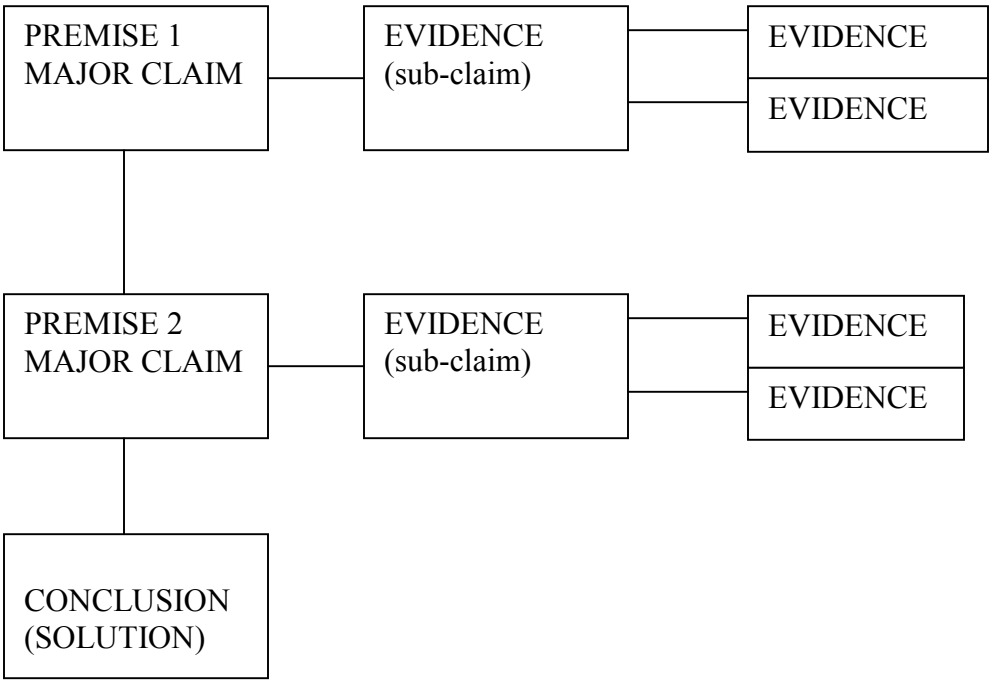
the state is getting safer. We could state the average unemployment rate and compare that to other states in graphic form.

Numbers require the same caution as authorities and you can apply the same criteria listed above. Be sure your numbers are relevant to your claim and that their source is reliable.

Much of the evidence we use when talking about large populations of people and events require that we use statistical inferences. Our claims about the quality of life in Pennsylvania can't require us to interview every resident. We have to use surveys based on samples. Indeed all our knowledge claims are generalized patterns we assume will be true without regard to time and place. We can't compile every instance of falling objects, or observe every dog in the history of the universe. We have to cite strategic cases from a number of different circumstances.

Mark Twain supposedly said, "There are lies, damn lies, and statistics." His point was that statistical evidence could be misused, misunderstood and misleading. Proficiency in statistical reasoning is a practical necessity for working, thinking and choosing in modern life. It requires far too much detail and explanation for this handout and you should make it a major goal of your education

You can't back up every statement with evidence without producing something unreadable. Therefore, decide which of your claims are crucial to your argument and support them. In some cases, you will need to make other claims (sub-claims or supporting claims) to make a strong case. A diagram of an argumentative essay supporting a problem solution would look like this:



Finally: What about Grades?

Problem based learning provides learners with the opportunity to become self-coaching. It helps you learn to evaluate your own performance and figure out how to improve. Every first-rate athlete does that. Mark McGuire listens to his manager and to the hitting coach, then he uses their comments to improve his swing, his timing, his stance and all the little details that when he gets them right mean record-breaking homeruns. He is his own coach ultimately, changing other players' and coaches' ideas about what is possible in homerun hitting.

That should be your goal as developing information scientist and technician – to use your instructors' evaluations and their models of expert performance to develop your own theory of coaching.

"But what about grades? What happens to my grade point average if I don't get A's? I won't even get admitted to the IST majors."

Grades are one of the most vexing problems of education. They are meant to tell students how well they are performing so they can change. If we were learning jump shots, the "grades" would be all the balls bouncing off the rim – the F's and D's and all the balls twitching the nets – the A's and B's. We wouldn't need any coach to tell us about our performance. Her job would be to help us perform better by watching our shooting stance, the arch of our ball, our follow-through and so on.

How do you know if your argument is sound, your presentation effective, your explanations meaningful, and your understanding useful? Schools use the mechanism of grades to tell you and to start coaching activities. They can also use grades to control – to force you to read assignments, be quiet in class and regurgitate back to teachers what they want you to say or write. Students can use grades to reflect on and improve performance or they can use grades to avoid the struggle of learning. If all you focus on is what you have to do to get an A you aren't likely to learn much.

Grades as feedback help you learn and become self-coaching. Grades as rewards and punishments take the fun out of learning and make classes boring and without risks.

Learning, however difficult, is fun and rewarding. In fact, when the brain learns something it releases the chemicals that produce the same delirious happiness you sometimes get from sex. Learning is also frustrating and demanding. There are times when we would just rather someone tell us what to do so we don't have to go through all the practice and failures. If you don't have periods of frustration and periods of excited happiness you aren't learning – or not very much.

Problem based learning was invented to promote a passion for learning. Medical schools found that after earning their degrees a large percentage of doctors quit reading any medical research. That meant that many physicians were prescribing treatments that were out of date. The cause of this lack of life-long learning was simple. The doctors

had come to hate learning. Listening, reading, and regurgitating memorized descriptions, terms, and formulas had wrecked their ability to enjoy medical learning.

A similar problem occurs among Penn State graduates. People who hire Nittany Lions report that PSU graduates don't like to learn. "What do you professors do to them?" one CEO asked me. "Whatever it is, you make them hate learning."

The best way to get some fun out of learning is to use the grades instructors give you as scores that you want to improve. Like dropping a pass or missing a free throw, a low score on an exercise doesn't mean you are a bad person – it means you made a mistake. You have to find out what you did wrong and try something different. That's the way we learn best -- by failing.

As strange as it seems the human brain is failure machine. It generates models of reality, acts on them, and adjusts or creates new models based on failures. Look at the life of a successful entrepreneur, author, artist or scientists and you will find a history of failures. Successful people use the failures to improve. Others worry over failure and try not to take chances. But there is not much to learn from success – indeed, we often learn the wrong things.

If you don't understand what you did wrong, contact your instructor or teaching assistant. Don't relax until you know exactly what you did, why you did it, and how to do it better the next time. If you read an assignment and can't understand it, don't keep reading it over and over. Get a classmate and talk about it. Discussion is a great learning tool. It helps you find out what you already know and it helps you look at ideas through different perspectives.

The less you worry over grades, the more likely you will learn. Don't work for the grade, work for the joy of doing a job well. The correlation between grade point averages and success in life – measured by satisfaction with work, family, community, plus income level – is close to zero. What does that mean? Mostly that the ability to memorize stuff doesn't help much in the work world. The abilities to understand and solve problems do pay off, but both require students to fail and learn.

Go for the learning. Watch yourself get better at arguments, at explanations, at finding sources. Take every opportunity to teach others. As your skills and performance improve your grades will follow. Your job is to become a passionate and life-long learner. That only comes from inner motivation – not the desire to please others.

Please send any questions, suggestions or comments to Larry Spence
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