

AC 2007-197: ENGINEERING IS LIFE: STORYTELLING IN THE MATERIAL SCIENCE CLASSROOM

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ABSTRACT

Storytelling has been used throughout time as a powerful educational tool to exchange and disseminate difficult ideas. Storytelling has found its rightful place in primary and secondary education through the years. However, its value in higher education has only been recognized recently. The reality is that we engineers may be the last to advocate for bringing drama or stories into our esteemed engineering classrooms. Wankat and Oreowicz contend that “all lectures are performances”¹. Joseph Lowman in *Mastering the Techniques of Teaching*, states that “college classrooms are fundamentally dramatic arenas in which the teacher is the focal point, like the actor or orator on stage”². What better way to break the monotony of information transfer than a good story. Papadimitriou has recognized three main ways of using storytelling in the teaching of a technical subject: (a) providing historical/biographical context to a subject, (b) illustrating a concept by a story, and (c) embedding educational material into a story³. This paper provides examples of storytelling in a Materials Science class and student reactions to the class. The paper is intended to serve as the starting point of an audience discussion during the presentation session.

INTRODUCTION

Storytelling has pedagogical importance in education and has long been used in the classroom. Back when science was being developed and passed along Aristotle and his peers used the spoken word, i.e. stories to teach all that they knew. Medical education has long realized the significance of stories and anecdotes and more recently articles show the practice in computer science education. Christos Papadimitriou an electrical engineer argues that “Stories are in a certain intrinsic sense interesting, in that they are attractive, high-priority memory fodder. Everything else being equal, we are much more likely to remember a story than a logical argument.” Now think about our typical student of today. In particular, the under-represented students need a format that relates to their background. Associated with this last point is the observation that storytelling happens to be alive and well, and broadly practiced, precisely in those places and cultures that are in dire need of CS and math education—the Third World and the ghettos of poverty and illiteracy³. In addition, women appear to be somewhat pre-determined towards storytelling. *Narrative Psychology* is a clear perspective within psychology concerned with the way students comprehend their world and their experience by constructing stories and assimilating stories by others.

Life moves at a fast pace for the millennial generation. Storytelling is constructive in teaching Engineering because it is different. We all know, variety is the spice of life and therefore desirable in education. Think about the typical university class, the M-W-F classes of fifty minutes are too many minutes and T-Th courses consisting of seventy five minutes can be an eternity. A good story can break the tedium of one-way information transfer. Stories combined with other active learning activities create a class that is difficult to forget.

This paper will share experiences from one Materials Science course and the conference presentation’s intent will be to also share the experiences of others from the distinguished audience.

RESULTS and DISCUSSION

The active learning activities and the stories must be tailored to the target audience. Many instructors have also recognized that "Successful teachers maintain close *contact* with their students during class. This *contact* makes them aware and responsive to their customers' needs"¹. Wankat and Oreovicz further state, "all lectures are performances." Many engineers deliver a lecture devoid of performance but they are quite competent, however "the ability to stimulate strong positive emotions in students separates the competent from the outstanding teacher"¹. Instructors must be confident in their subject matter because students can smell weakness but with wit, a variety of activity, an animated delivery, enthusiasm for the subject matter, and the presence of drama in the classroom, strong emotions can be cultivated which in turn lead to memories. Neurological findings also support the realization that narrative memory is concentrated in the hippocampus, as opposed to the cortex⁵. To get the hippocampus activated, each semester begins with a story and an affirmation that the students already know a lot about Material Science. Imagine it is Thanksgiving morning and you are at home. The cooks are in the kitchen. Even your grandmother knows some material science. Think about cooking surfaces and the pots and the handles and the plates and the bowls etc. Now let the students discuss the differences.

Papadimitriou identified three principal ways of using storytelling in the teaching of a technical subject like computer science: (a) providing historical/biographical context to a subject, (b) illustrating a concept by a story, and (c) embedding educational material into a story³. These means are also applicable in the Materials Science classroom.

(a) An example of providing historical/biographical context to a story would be to discuss your own education and or research experiences and results, good times and bad, the time I was an undergraduate and was on the payroll to polish and then etch samples for hours, I still have the scar on my finger where I ground flesh instead of the steel. A real story builds your credibility, and a valid impression of your expertise. Take a few minutes when you return from a conference and share with them the presentations that excited you. This is invaluable when you need to influence others. Another example would be to use historical stories such as the Titanic sinking but the story must be told with gusto trying to involve more than just the sense of hearing. Oral language uses more channels – be conscious of what all channels of communication are saying: Body, Eyes, Gestures, Face, Words, Tone, and Timing. When words and tone conflict, tone wins.

(b) The second method of utilizing storytelling is to illustrate a concept by a story. When using the method of illustrating a concept by a story we let students come to their own conclusions vs. reporting our own conclusions. Direct them through a progression of steps 1, 2, 3 and then instead of giving them 4 let them come to their own conclusion.

Let's imagine our classroom is a crystal lattice you are all *Stu* atoms and you have formed a single crystal or grain because all of the chairs are laid out in straight lines. We are very similar to a real crystal structure. Look around; there are vacancies, of roughly the same size. Now what happens when we bring in a pre-school class? Where do they sit? Now is the point where

the students progress through to their own conclusion. They will answer and now you have a perfect example of interstitials.

Have you ever gone shopping with a two-year-old? They think they are too old for a stroller and their favorite phrase is I can do it!, but their little legs can't move very fast. How fast can you shop? Who controls the speed of the process? It really doesn't matter how fast you can shop, the slowest member controls the reaction. Now let's think about a new precipitate trying to form. If we are just below the reaction temperature the relative temperature will be high so diffusion will be fast but, the system is quite close to its equilibrium so the driving force for nucleation is slow, so we have to wait on the nucleation. There are 2 parts to the reaction but the slowest is in control!

(c) Lastly are examples of embedding educational material into a story. Have you ever been on a plane or bus and your seat-mates are unknown until you arrive. Now I have an aunt who is a wonderful person but she weighs over 300 lbs. How would you feel if Aunt Ida arrived in the seat beside you for the trip to San Diego? You likely are stressed, slightly compressed. We call these internal stresses and this is what goes on when a material is solid solution strengthened.

Do you remember when you were grade school students and you were expected in PE class to learn to ballroom dance? Think back, those were the days of Cooties, girls on one side, boys on the other, your diffusion coefficient was very low. Now time passes, you are in out at the club, no one even thinks about diffusion coefficients, you now have complete solid solubility.

The biggest hit however is the day we discuss dispersion strengthening. Remember, memories last longer when more of the senses are stimulated. This is another method that promotes contact with the students. Chocolate chips now come in many sizes, and the night before class several batches of cookies are baked.

- 1) One batch is chocolate-less, i.e. a solid solution with no precipitates.
- 2) One batch is mixed with 12 ounces of mini chips
- 3) One batch is mixed with 12 ounces of standard chips
- 4) One batch is baked with 12 ounces of chocolate chunks.

Each student is given at least two different style cookies and are asked to make observations of the ease with which they bend and break. The batches 2-4 contain the same amount of chocolate yet their dispersion is quite different and therefore their properties

As evidence of the success of this method several factors are presented, these are not firm quantitative measures as this effort is not to that stage. The grade distribution for the class is somewhat bell shaped in that there is not an over abundance of A's and B's, Figure 1. The instructor is reputed to be hard, give lots of work but really keeps it interesting. There are two different sections of the same course offered yet this particular section of the Materials Science course in which more story telling is utilized is always max enrolled, 50 students versus 20. Blackboard is utilized to administer a mid-course analysis. The questions and answers presented in Figure 2 are pertaining to the storytelling method as well as the contact the instructor maintains with the students. Responses from the University administered end of course

evaluation are also presented. Both qualitatively demonstrate the student's opinions about the method used.

Figure 1. Materials Science grade distribution for the past 3 semesters.

A	B	C	D	F	W	Total
25	42	50	23	14	15	169

Figure 2. Sample questions from the survey created and administered via Blackboard site along with select answers.

Question 1: Multiple Choice

Which of the following best describes your reason for taking the course?

Answers	Percent Answered
Major/minor requirement	90.9%
Major elective	9.099999%
General education	0.0%
University Elective	0.0%
Unanswered	<0.0%

Question 2: Essay

What are things you like about the class?

I like the way the professor uses examples and hands on items. I believe the professor works hard to cater to everyone's learning style. I also believe the students feed off of the positive energy the professor gives in class. The professor loves what she does and this helps keep the students involved. The professor paves away for students to learn by having people work together in class and outside of class. Overall, this course is a pretty interesting course.
I like Dr. Waters' enthusiasm about the subject matter, and her ability to provide real-world examples to better explain the technical terminology in the textbook.
I like the excitement and the energy that the teacher brings. This keeps the class fresh, new and interesting. I never considered materials science beyond my requirements but I believe this is something that I could see myself doing in graduate school.
Involvement with the students.
i like the instruction. i feel you have an excellent way of teaching and getting us to understand it
I like seeing how the things we are learning is applied in real engineering projects.
I like that the professor is enthusiastic about the class. I feel that she really wants me to know the material that we cover in class. This in turn motivates me to also be enthusiastic with the course.
I like that Dr. Waters makes the class very interactive, meaning she keeps us involved during her lectures. I also like that she gives us homework before the material is covered, it makes you read the chapter before the next class.
I like the lectures because they are actually interesting and they give examples of real life situations which is what I like. I like the pre-quizzes because that means that I actually have to read the chapter before taking them.
Dr. Waters in a very vibrant instructor that keeps you awake with her lectures in class and provides great visuals during class
*Professor cares enough about students to learn their names.

<ul style="list-style-type: none"> *I like the structure (list of due/event dates).It helps the students to pace themselves. *Interactive & engaging lectures. *energetic lectures. *Professor uses divers methods to communicate concepts and is not limited in the use of examples. *Lots of supplemental material and information is made available. *Course is frequently related to the professional (post-secondary) context and examples of practical applications of subject matter is given. *Instructor's desire to improve the class through student input such as this.
The teacher is not boring like many I previous teachers. She catches you and you have no choice but to pay attention.
I like that it may prepare me for other course or in my line of work.

Question 3: Essay

Is the difficulty of the course in line with your expectations?

Yes. The course it challenging, but not as difficult as I thought.
It is a little bit harder than expected, but it's a good challenge
Personally, the course is just right. It's not too hard and not too hard. It's enough to make you work.
Well the class itself is not as difficult as I thought it would be. The hard part is keeping up with all of the assignments.
The difficulty of the class is pretty much in line with my expectations. I expected the class to be challenging and it is. It is challenging but the teacher offers every possibility for success.
The difficulty of the course is everything I expected and more. I knew it would demand a great deal of time for things such as homework problems, and reading materials.
In the beginning of the class I was not sure if I could meet the expectations of the course, since I need to see few examples before I have a good understanding of the material. I realized I had to spend lots of time on my own trying to understand the material, however the recitation has helped me as well.
I did not, however expect to have two homeworks due every week, but I must say that I have learned very interesting things.
Yes it is. The material requires you to use your brain, but it doesn't drive you crazy to the point you feel you're helpless. Also, the amount of work is not too much... at the moment.
the course material itself I feel is what I find to be difficult. Since I am not a chemistry fan the course meets my expectations as regards to the level of difficulty.
Yes, this course is very demanding. It makes you think but I would agree that you learn a lot.
Yes, this course is actually everything I expected. I had an idea that materials science covered alot of material. And as I thought, it really does. The studying time necessary exceeds all of other classes that I have been enrolled in. But then again science courses have always been my weakest courses. So it means alot to me for me to do well.
The course is more difficult than I expected, however I am up to the challenge of learning in depth why materials behave in the manner that they do.
Yes, I expected the course to be difficult mainly because the subject of material science is not an easy topic in its self. Also because preivous students warned me of the difficulty level. This course requires me to think and apply what I learned previously in Chemisty, I actually enjoy this because I am learning.

Sample responses from the University administered teacher evaluation are as follows and support the success of the active storytelling method.

1	Great class with great info very interested
2	Her class is super hard but for the most part she is fair. I'm still trying to figure out how she has so much energy everyday when she teaches
3	Dr. Waters is one of those unique professors that actually cares but will not just hand it to you. The course as a whole needs to be at least 3 credit hours because there is just too much information to condense in the time frame.

4	Great teacher! A lot of energy! Always willing to help in any way possible!
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5	Love the cookies
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CONCLUSION

In conclusion, research from many different fields and our own experience shows that teaching effectiveness is a result of two different factors. The first is the instructor's ability to stimulate intellectual excitement in the classroom. Student survey responses as displayed previously verify the success of this method. The second dimension is grounded in the psychology of the classroom. An effective instructor is one who promotes positive student emotions by fostering critical thinking and creativity, one who increases the amount of “contact” in the classroom, and one who promotes an atmosphere of respect. This paper has presented several brief examples of the use of storytelling in an introductory Materials Science class. Qualitative responses indicate that students enjoy this mode of presentation. The author hopes that this paper can serve as a starting point for a larger discussion and sharing of storytelling ideas.

REFERENCES

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