

## **How to Develop Engaging Engineering Content for the Classroom and On-line Videos (Mini-Class Demo)**

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# How to Develop Engaging Engineering Content for the Classroom and Online Videos (Mini-Class Demo)

## Abstract

Let's face it- no one wants to watch an instructor talk for hours on an engineering topic, especially with so many distractions readily available to students on the computer that are simply one click away. Even video content that includes well-edited animations and graphics can still be boring when presented by the voice of an unseen orator. Students want teacher immediacy.

The following video documents the adventures of one civil engineering instructor who has sought to provide amusing and informative classroom experiences and online educational videos. The video will describe planning the content, delivering the content (including how to develop scripts and costumes), using real-world examples in the content when possible, and implementing the lessons.

As online video content continues to remain popular with college students, this video "paper" challenges the norm that academic documentation must appear in written form in either journals or conference proceedings. However, for anyone who is not used to watching online videos to learn new topics, a short, written paper will accompany the video.

## Act I: Exposition [1]

Ace, short for Acero, is excited! After many years of studying, he is ready to enter his first college classroom as the instructor. As he looks forward to his first class next week, he begins to feel nervous at the thought of presenting information in front of so many engineering students, many of whom are much younger than he is and therefore, may have distinctly different ideas about classroom instruction.

Suddenly, a number of questions flash into Ace's mind:

- What will he teach?
- How should he prepare?
- Will the students enjoy the class?
- Most importantly, will the students learn?

Ace cannot believe how nervous he feels in anticipation of the class. It reminds him of the fifth grade when he was the lead in the school play. He remembers staring aimlessly at a sign above the classroom chalkboard that read "Prior Preparation Prevents Poor Performance", while he nervously read and reread his lines. Perhaps this serves as a useful adage in all areas of life, whether you are going to run a marathon or teach a class. It goes without saying that the best teachers do not enter class on a whim without a plan, but rather they have meticulously planned and practiced every detail so that the performance seems natural, much like a well-rehearsed play. And like the lead in the play, Ace will need to weave the story for his students, helping them to not only apply the engineering design principles to real life, but to acknowledge the development of these equations and standards as they have evolved alongside the technology used to analyze engineering projects.

After all, the classroom can be seen as a dramatic arena, in which the instructor is giving the performance on stage (sometimes, actually on a raised platform at the front of the room) while the audience of students observe [2].

## **Act II: Rising Action**

But if Ace is to approach class as a story, he must well prepare the tale of engineering that he will share, for, “The best teaching is often both an intellectual creation and a performing art” [3]. Quickly, Ace researches how to construct a story- surely all those hours spent on his cell phone (upwards of 8 hours for college-aged males and 10 hours for college-aged females [4]) watching Netflix, YouTube, and talking to friends would have prepared him to tell a simple story.

Stories have long been used as a means to pass history between generations, a technique still heavily relied upon today in Native American tribes of the Southwest [5]. Not only are stories used to record history, they are a powerful tool that can capture the attention of millions.

“Teaching is ‘above all,’ Michael Sandel, a Harvard political theorist, argued, ‘about commanding the attention [of the students] and holding it’ [3]. He goes on to contend that our task as professors is not unlike that of a commercial for a soft drink or other product- what differs, is what professors do with the attention once they have it.

Stories are not just a means to record historical events but can be a powerful way to teach lessons. Jesus Christ, arguably one of the most influential individuals in history relied heavily upon the use of stories (parables) and metaphor to teach His disciples, who in turn have passed these stories down for over 2000 years.

Not into religion? If your faith lies instead on the future of Artificial Intelligence, then consider that ChatGPT lists “storytelling” as its number 2 strategy when asked how to make engineering videos more engaging [6].

But Ace sets these notions aside as he prefers to consider more scientific literature regarding mental cognition. Just then he reads remembers that the art of storytelling is embedded in our minds from childhood and is one of the first means by which most humans are taught to express themselves [7]. It is one of the earliest ways children are able to grow language skills, so it makes sense that stories have a special place in constructing the narrative of life, which can include our engineering disciplines.

## **Act III: Climax**

Armed with a plan, Ace meticulously plans the story of his engineering lesson. He knows that he must not only deliver on the intellectual content, but that he has a role to play, an act to perform, to meet the students’ expectations.

Just like any play, the setting is important. Ace must provide a positive learning environment for his students by planning the logistics of class, down to the minute for a flawless performance. It is not enough to have a general idea of what activities in class will take place, but to also know who

will be engaged in these activities, where they will take place (on the board, in student groups, conversations between the instructor and student), and how they will facilitate the story of learning. Many professors focus on having some magic formula of active learning strategies plus lecture, which is necessary, but the truly great professors know exactly where the story is heading and can facilitate a critical learning environment where the students are the authors of the story, asking and answering their own questions to learn the engineering principles [3].

Like many plays, props are essential to performing the scenes! Ace immediately determines which models and classroom demonstrations will best explain the engineering principles, as they are a crucial portion of an engaging classroom [8]. As Ace stares at the model, he is suddenly inspired to tie the model to a theme, one in which might produce a little drama in the classroom to provide some student interaction, fun, and perhaps shock and awe at the demonstration of fundamental engineering principles [9,10]. Themes can be useful in the classroom because “Humans are fundamentally hard-wired to remember stories, and when they do, the scientific principles associated with them will be retained” [11].

As he wakes up on the morning of his first class, Ace is confident that his class has been adequately prepared. He has been sure to provide a variety of teaching techniques so that the class appeals to students from both individualized and integrated cultural frameworks [12]. Like his play in fifth grade, he has rehearsed his presentation. While not every line needs to be memorized, it is imperative that he sticks to the schedule, marking times for when content should be introduced, discussed, and debriefed.

With one last look at the clock, he realizes show time is about begin. The nerves reach an almost nauseating level as Ace panics one last time that there is some element he has forgotten in preparation. What if the students really do not like his class? Will they throw tomatoes at him? Boo him? Or even walk out on him? He glances one last time at his desk and finds comfort in a yin-yang symbol he had once 3D printed for himself. He knows that whether they like the performance or not, that students having the opportunity to learn in “both the comfort of their own culturally natural framework and the challenge of negotiating other cultural frameworks” will lead to “the balance of comfort and dissonance necessary for complex learning” [12].

And with that Ace walks out his door to step on stage.

#### **Act IV: Falling Action**

Ace enters the classroom with such excitement and enthusiasm for his topic that students are immediately drawn to him. The students set aside their lives, their phones, their worries and become immediately engaged in the content. Ace uses variations in tone to deliver the performance, for even the most traditional lecturing professors know that they must project differently depending upon the size and placement of the audience in order to acquire their attention [3]. While teaching is not acting, great teachers expect to affect their audience when they speak to capture their attention and provoke thoughts and question [3]. For even the famed educational psychologist Benjamin Bloom understood that learning takes place in not only the cognitive domain, but the affective and psychomotor domains [13].

Ace is pleased with the class as it unfolds. Like a good story, there has been action and adventure, as well as reflection and thoughtful application (of the engineering principles). Just as he reaches the end of the lesson and is about to close with a thought-provoking question, one of the students in the back corner of the classroom nearest the door stands up. Ace pauses mid-sentence and stares for one second, crestfallen that the student is about to walk out on him. While thoughts of failure and ways to improve race through his mind, a sudden “CLAP!” grabs his attention!

### **Act V: Resolution (or Catastrophe)**

The clap is followed by another clap, and then another, as student after student begins to stand and applaud his performance. While it certainly might not have been what they were expecting, students know what good teaching looks like and know that Ace had a plan from the very beginning to guide their learning experience. Sometimes, the display of effort and willingness to be vulnerable and risk your own reputation will help students relate to you. Once the students trust the instructor’s intentions, knowing that the instructor is not a gatekeeper or guardian of knowledge, but a similar human being with learned experiences to share, they can begin the long, difficult journey to master the engineering content... END OF STORY.

### **Summary**

The preceding paper seeks to summarize a number of ideas the instructor and the cited references have deemed effective in creating engaging engineering content for classrooms and videos. Overall, the following three topics are central to creating engaging content:

- *Story*- For thousands of years, humans have passed on history orally to one another using stories. In fact, as children, stories are one of the first ways one interacts with the world and learns to express himself or herself [7], thus making it a natural learning mechanism that can be taken advantage of at any stage in life [11]. In an integrated cultural framework, stories can help students relate new concepts to existing knowledge, making it a culturally responsive practice for the classroom [5] [12].
- *Themes/Drama*- Adding drama into the classroom in the form of experiments can force students to critically think about the taught content and apply the engineering knowledge before confronting them with a possibly new way or context to understand engineering behavior. Bain reported that the best teachers create an environment that stimulates critical thinking [3]. The ASCE ExCEED Teaching Model and program encourages the use of physical demonstrations to teach engineering [8], including a module on using drama in the classroom [9]. The author has previously implemented themes/drama into an engineering mechanics of materials course and demonstrated its effectiveness for improving student learning and the student experience [10].
- *Excitement*- Perhaps the most important attribute an instructor could display is pure excitement and enthusiasm for the topic taught. When considering other forms of entertainment, people are captivated by excitement and are often eager to watch dramatic stories and will spend hours to do so [8]. The paper highlights the importance building excitement by being divided into five acts, similar to many famous Shakespeare plays and

other dramatic works [1]. At other times, just the shock factor of using a theme or new technique of getting the student's attention will help aid retention [8-10]. The author attempted to help catch the reader's attention by using the recent and currently disputed reputation of ChatGPT [6] as a referenced source within the paper. Whether or not all the items suggested by ChatGPT to increase engagement are able to be verified as accurate, the author believes there is value in its ability to summarize and represent the information on the Internet it uses as its source to formulate an opinion.

## **Student Feedback- Qualitative**

While the author has not formally studied the effectiveness of his videos at increasing student engagement, some qualitative and quantitative data are provided to show that students are more interested in the content. The data is taken from the following Mechanics of Materials classes, which made online videos available to the students:

- Spring 2020: in-person class that transitioned online for the second half due to COVID-19; online portion was taught asynchronously with videos the primary teaching mechanism
- Summer 2020: asynchronous online
- Spring 2021: in-person class, where some videos are used to prepare students for working examples in class or are used as an alternative to class time to provide more time for labs; all videos were available if students wanted to revisit topics
- Summer 2021: asynchronous online

*What is your opinion about the different "themes" or "costumes" throughout ENGR 2332? For instance, did they make you enjoy the class and look forward to subject matter? Or did you find them distracting and were unable to take the class seriously?*

- I enjoyed them.
- I thought that the themes and costumes for each class day made me more excited to come to class. With most engineering courses, everything can become a bit repetitive and boring at times. This aspect of ENGR 2332 actually helped keep my interest focused on the material taught throughout the course this semester. A class taught like this helps me remember the material by associating it with certain parts of the themes or costumes that were involved.
- I loved the themes of each lesson, made the class fun and engaging!
- I loved the costumes and themes. I found it an easier way to understand the material since there was always some sort of connection between the two. I was able to remember the theme or costume that went along with the equation during the tests.
- It helped me learn easier.
- Absolutely loved them. Looked forward to class. Made the long class bearable. Favorite class this semester!!
- I enjoyed the different days of class because there was always a theme. Having a theme for the lesson made the class more fun.
- They made the class so much more exciting to go to every day. This was my favorite class I have taken my whole time at ASU!

- I think that just the effort put into the class and labs was more than enough and is beyond what ive seen from any other professor. Yes it helped me enjoy a 2 hour class a whole lot more than I would have otherwise.
- I enjoyed the themes. Law and order with Tresca made the material more enjoyable to watch.
- I really enjoyed the themes! They kept me hooked and interested in the lessons instead of dozing off. And to see a professor put effort into their work was really appreciated. thank you!
- Sometimes a little distracting, but overall funny and themes make you remember the chapters more easily. I think it is a good idea to continue doing this but maybe a little bit more serious for some video's.
- i love them!!!
- Amazing, may I suggest Scooby-Doo?
- I liked them very much and do not think that they took away from learning, but rather engaged us to be more alert during the class period. It is very nice to be able to smile while learning the content.
- I loved the themes, keep up the EXCELLENt work
- I enjoyed the themes of the class and it was encouraging to see how creative engineers can be. I can't say that the themes made me excited for class but I am naturally more reserved. I feel that the ice- breaker for the class was a little overwhelming but a good tool to show how the class works.
- I loved the themed approach. It made the learning fun and engaging.
- the helped keep my attention through a 2 hr lecture great job
- they definitely made learning more enjoyable and memorable
- I found it very cool how you could relate engineering terms to costumes and themes.

### *Comments*

- Excellent teacher! Love your teaching style keeps me engage!
- thank you dr. Batts for giving it your all. I truly appreciate every class
- He made the material really enjoyable to learn! Although it was online, I really appreciated how much effort was put into the course. It helped me understand material with how creative the lessons were. This was a very great course to take. The material was interesting and the professor made it a fun course.
- I enjoyed this class very much. The real life examples help tremendously and you do a phenomenal job relating the material to us.
- Best Professor in the engineering department!!!
- enjoyed this class very much, can't wait to take steel design and structural analysis with you!
- dr batts loves what he teaches and always takes time to set the stage for his class lectures. amazing job.

## Student Feedback- Quantitative

Table 1: Student Feedback Survey Results (5 Point Likert Scale)

Question/Student Objective	Spring 2020	Summer 2020	Spring 2021	Summer 2021
Number of Students Responding	10	3	13	2
Total Number of Students	12	10	19	13
Made it clear how each topic fit into the course	4.90	5.00	4.92	-
Explained course material clearly and concisely	5.00	5.00	4.92	-
Related course material to real life situations	5.00	5.00	4.92	-
Introduced stimulating ideas about the subject	4.70	4.67	4.85	-
Learning to analyze and critically evaluate ideas, arguments, and points of view	3.40	3.67	4.15	-
Overall, I rate this instructor as an excellent teacher.	5.00	5.00	4.69	-
Overall, I rate this course as excellent.	4.90	5.00	4.69	-

## Final Thoughts

One of the most significant skills displayed by excellent teachers is the ability to communicate orally in ways that stimulate thought [3]. In academia, the written word tends to hold a special status that oral communication does not [3]; yet just as in good writing, there is a certain craft in the spoken word that needs to be honed to create a thought-provoking, critical thinking, learning environment for students.

It is hoped that the story of Acero, laid out in a classic five-act structure [1], has impressed upon you the significance of oral communication and storytelling in the classroom and inspires you to plan new ways to create engaging engineering content for both the classical classroom theatre and the modern online cinema.

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