Teaching & Learning Engineering: a tango

What does it take for your students to learn something new?

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So, what exactly does it take for your students to learn something new?

Workshop Goals:

- ***Explore*** our own Learning.
- ***Understand*** what it takes to learn something new (Conditions of Learning).
- ***Apply*** this understanding to our Teaching.

My Story

Take 3 min to think individually:

- ... about a time when you were trying to learn something new and you succeeded.
- What contributed to your learning?

Take 3 min to share in groups of 3:

- Exchange stories.
- Come up with **key words** to describe what contributed to your learning experience (e.g. practice, persistence, etc.)

CONDITIONS OF LEARNING

(Brian Cambourne)

1. Immersion
2. Demonstration
3. Engagement
4. Expectations
5. Responsibility
6. Approximations
7. Employment (Practice)
8. Response (Feedback)

Where did this theory come from?

- Brian Cambourne, in his effort to find an educationally relevant theory of literacy learning, conducted research with young children for a period over 20 years, from the early 1970's to the mid-1990's.
- My Thesis: 8 Conditions of Learning are universal!

IMMERSION

- The state of being saturated by, enveloped in, flooded by, steeped in, or constantly bathed in that which is to be learned.
  - ✓ Learning to talk: auto-satisfied
  - ✓ Learning tango in Buenos Aires…
  - ✓ Learning soccer in Latin America…
  - ✓ Learning music

Immersion: ideas

- Internships / Co-ops
- Service Learning
- Hobbies
- Field trips
- Web: access relevant info anywhere, anytime!
- Decorations

Curtiss T-32 Condor, 1933

2nd generation biplane transport, V =145 mph, 12 passengers

1st modern air transport: Boeing 247, 1933

clean design, 10 passengers / 2 pilots / 1 steward, 160 mph, only 75 were built !!

Like this, only better!

DC-3, 1936

V = 185 mph, 21 passengers

Built: 10,654 DC-3 & C-47 + 2,500 Li-2 (Soviet Union) & L2D (Japan)

Immersion
…as a result of Passion

- ✓ *…the delight of being totally within one's own element – of identifying fully with one's work and seeing it as an expression of one's own character.*
- ✓ *This affection must be so strong and genuine that it persists during leisure hours and even makes it into dreams.*

Immersion as a result of Fidelity

- Attention to one's subject should be so generous, extended, and intimate that the idea virtually inhabits the mind.

The Creative Mind, Ch. 2 Inspiration, Fidelity

DEMONSTRATION

The ability to
- ✓ observe,
- ✓ see,
- ✓ hear,
- ✓ witness,
- ✓ experience,
- ✓ feel,
- ✓ study,
- ✓ explore

actions and artifacts.

- ✓ Learning to talk: auto-satisfied / whole demonstrations
- ✓ Learning tango in Buenos Aires...
- ✓ Learning soccer in Latin America...
- ✓ Learning music

Are we purposely hiding demonstrations from our students?

Student Comment:

Example problems done in class are a decoy, to lure you away from potential exam material !

Demonstration – ideas

- Make some of them "whole"!
- Give the big picture (important for global learners).
- Learner does not need to grasp everything at once.
- Case studies.
- What's unstable?

Calculate the skin-friction drag of a flat plate with a span b=5 m and a chord c=1m for an airspeed of 5 m/sec.

For sea-level, standard air the density is $\rho = 1.2\ kg/m^3$
and the viscosity is $\mu = 1.789 \times 10^{-5}\ N.sec/m^2$
The Reynolds number for the flow over the plate is

$$Re = \frac{\rho U c}{\mu} = \frac{1.2(5)1}{1.789x10^{-5}} = 3.35x10^5 \le Re_{cr} = 5x10^5$$

so the boundary layer is laminar. The skin-friction coefficient for the plate can be calculated from:

$$C_F = \frac{1.33}{\sqrt{Re}} = 0.0023$$

The surface area of the plate on one side is:

$$S = bc = 5(1) = 5m^2$$

while the dynamic pressure of the free-stream is:

$$q = \frac{1}{2}\rho U^2 = 15N/m^2$$

Finally, the skin-friction drag of the plate is

$$D = 2C_F qS = 2(0.0023)15(5) = 0.345N$$

Un-whole demonstration ☹

Piaggio Avanti P-180

ENGAGEMENT

means:

- Attention which comes as a result of a perceived need or purpose for learning in the first place.
- Active participation by the learner, which in turn involves some risk taking.
- Very little learning can occur w/o it!

ENGAGEMENT

learners must be convinced that:

- Are potential doers of the demonstrations they are observing.
- Engaging will further the purpose of their lives.
- Can engage and try to emulate without fear of physical or psychological hurt if their attempts are not correct.

Engagement:
what can we do ?

- Probability of engagement is increased dramatically if students:
  - ✓ Bond with us.
  - ✓ Think highly of us.
  - ✓ Believe we like them, care about them.
- $$$ is not a strong motivator!
  - ✓ and neither are extra points ☹
- Inspiration!

Engagement as a result of Passion

- *…the delight of being totally within one's own element – of identifying fully with one's work and seeing it as an expression of one's own character.*
- *This affection must be so strong and genuine that it persists during leisure hours and even makes it into dreams.*

The Creative Mind, Ch. 2 Inspiration, Passion for work


I wish I had employees like you! You're perfect. What's your secret?
I love what I do, I love the people I work for, and I love that they appreciate my work. I would do anything to make them and the customer happy.
Copyright © MMXIII Shep Hyken
"An engaged employee, is a fulfilled employee."

EXPECTATIONS

Students:

- Achieve what we expect them to achieve and fail if we expect them to fail.
  - ✓ Learning to talk: auto-satisfied
- Bella Carolyi – Kerri Strug
- Give them the message that we expect them to learn whatever it is we teach them.


EXPECTATIONS
A master can tell you what he expects of you.
A teacher, though, awakens your own expectations. (Patricia Neal)

Expectations

- Avoid hinting that the task is ***too difficult***.

- Importance of teacher / student relationship.
  - ✓ Students are more likely to engage in demonstrations of teachers whom they regard as significant and hold high expectations for them.

FOR EVERYONE'S CONVENIENCE, WE LIKE TO GO OVER THE EMPLOYEE WELCOME KIT AND TERMINATION PACKAGE AT THE SAME TIME.

Expectations:
what can we do ?

- Be positive!
- Be genuine and realistic!
- Know our students' abilities and challenge them to the fullest of their capacity;
  - ✓ too simple a task - boredom
  - ✓ too challenging a task -anxiety
- Maintain good rapport with students.

Expectations:
examples

- Guidelines for report writing / problem solving.
  - ✓ Return ungraded !
- Design Competitions
  - ✓ No passing grade if plane doesn't fly…
- Come to class prepared for problem solving!
  - ✓ Humanities professor…


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www.CartoonStock.com
PERSONNEL
searchID#:mban1277
"Thanks for coming in. We'll get back to you as soon as we lower our expectations."

RESPONSIBILITY

- Students are allowed to make some decisions about when, how, and what "bits" to learn in any task.
  - ✓ Learning to talk: auto-satisfied (how?)
  - ✓ Learning tango: improvisation!
- Learners who lose the ability to make decisions are disempowered.
- Lifelong Learning!

Responsibility: students:

- Take responsibility to learn some things on their own.
- Design, not simply perform experiments in the lab.
- Occasionally present new material in class.
- Portfolios, choice of assignments.
- Constructivist approach.

Seymore Papert
Cognitive Psychologist:

Better learning will not come from finding better ways for the teacher to instruct but from giving the learner better opportunities to construct !

APPROXIMATIONS

- Students are not expected to wait until they have completely mastered a skill before they are allowed to use it.
- They “have a go” (i.e., attempt to emulate what is being demonstrated).

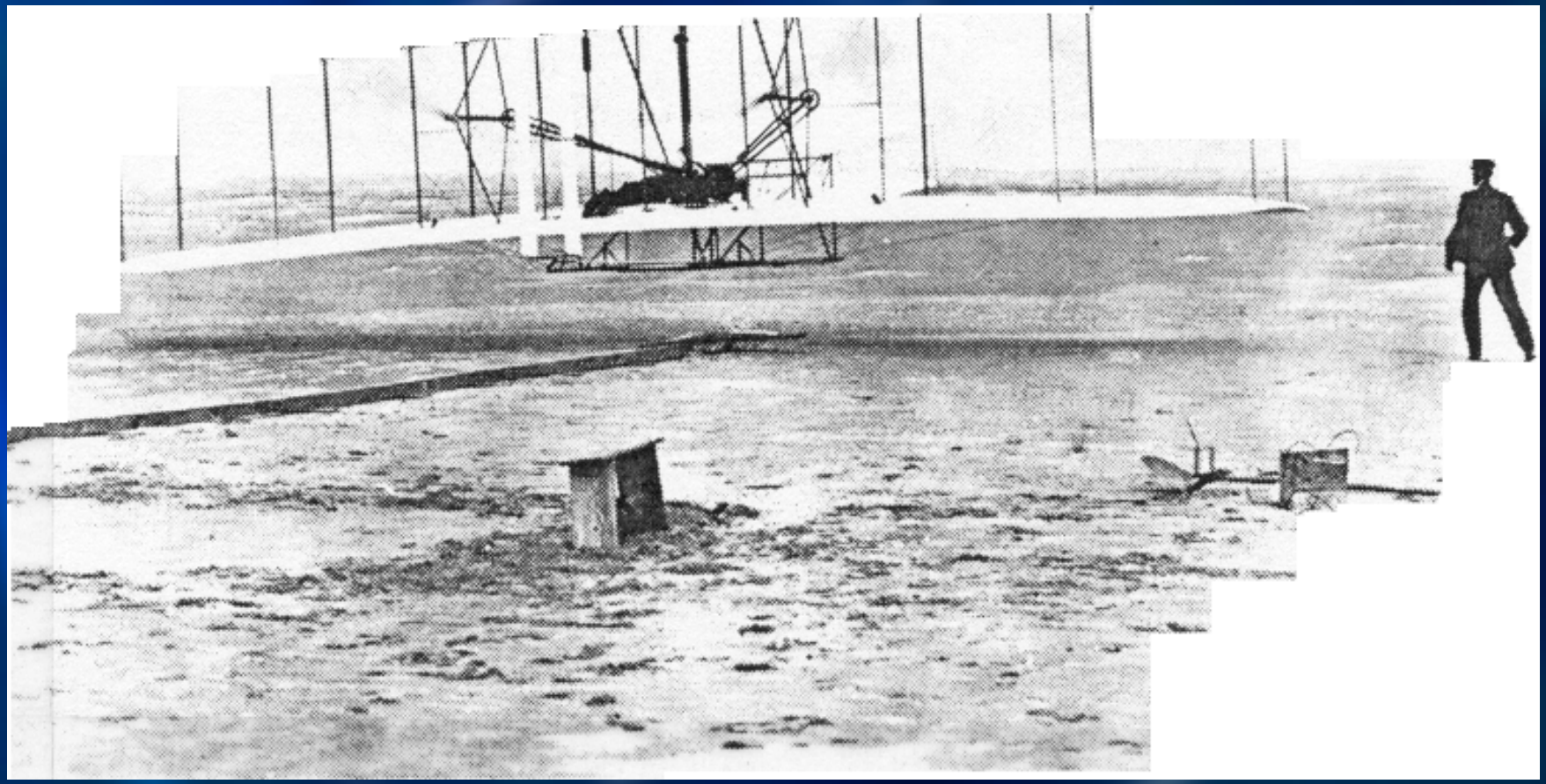
APPROXIMATIONS

- Learning to talk: Attempts of the learner, though not perfect, are received enthusiastically, warmly, and joyously.
- Mistakes essential for learning.
  - ✓ Learning tango
  - ✓ Learning engineering

Approximations

- The role of failure in engineering; design & iteration !
  - ✓ "Nobody will fly for 1,000 years!" Wilbur Wright, 1901.
  - ✓ Allow + Reward reworking papers, homework problems, design / lab reports.
- AL in the classroom !
  - ✓ Opportunity to approximate when feedback is readily available.

Wright Flyer, 1903.



EMPLOYMENT (practice)

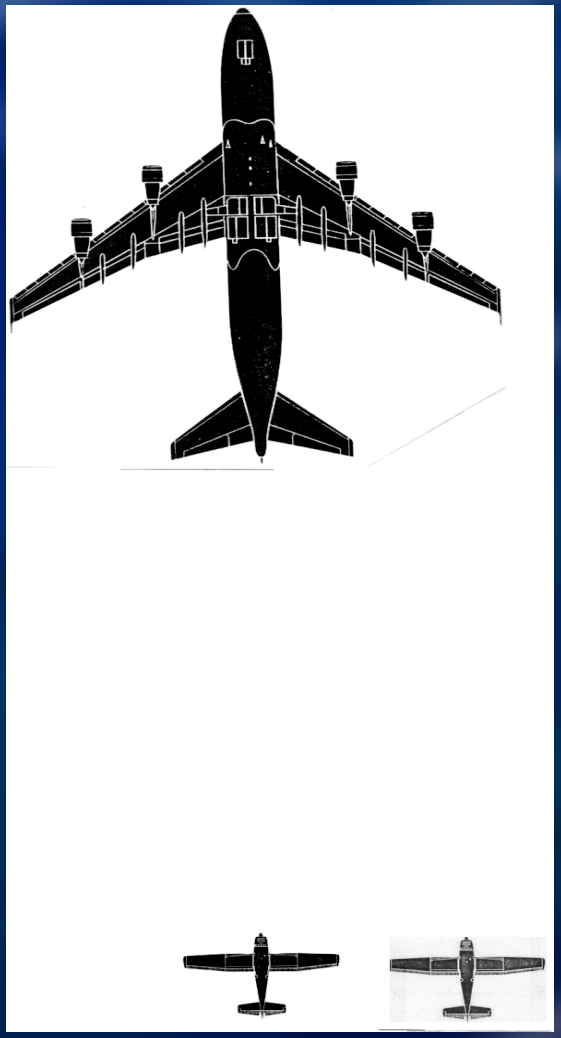
***Learning to talk*: need time & opportunities to use, employ, and practice developing language skills.**

Practice: some ideas

- Must be meaningful!
  - ✓ language learning
  - ✓ learning soccer
  - ✓ learning guitar
  - ✓ learning tango: social dancing, performing
  - ✓ learning engineering?
- Must relate to something in students' personal lives ! (Reflection Journals)
- PBL, IBL, AL in class

A tip-vortex from a crop-duster

C-152 following B 747



Chickering & Gamson, 1987

"Learning is not a spectator sport. Students do not learn much just by sitting in class listening to teachers, memorizing prepackaged assignments, and spitting out answers. They must talk about what they are learning, write about it, relate it to past experiences, apply it to their daily lives. They must make what they learn part of themselves."

RESPONSE (Feedback)

- *Learning to talk*: need feedback from exchanges w. more knowledgeable others (parents, siblings, relatives).
- Response must be relevant, appropriate, timely, readily available, and non-threatening, with no strings attached.
  - ✓ learning soccer / coaching
  - ✓ learning guitar
  - ✓ tango privates
  - ✓ learning engineering? (teacher, classmates, engineers from industry, etc.).

Feedback: some ideas

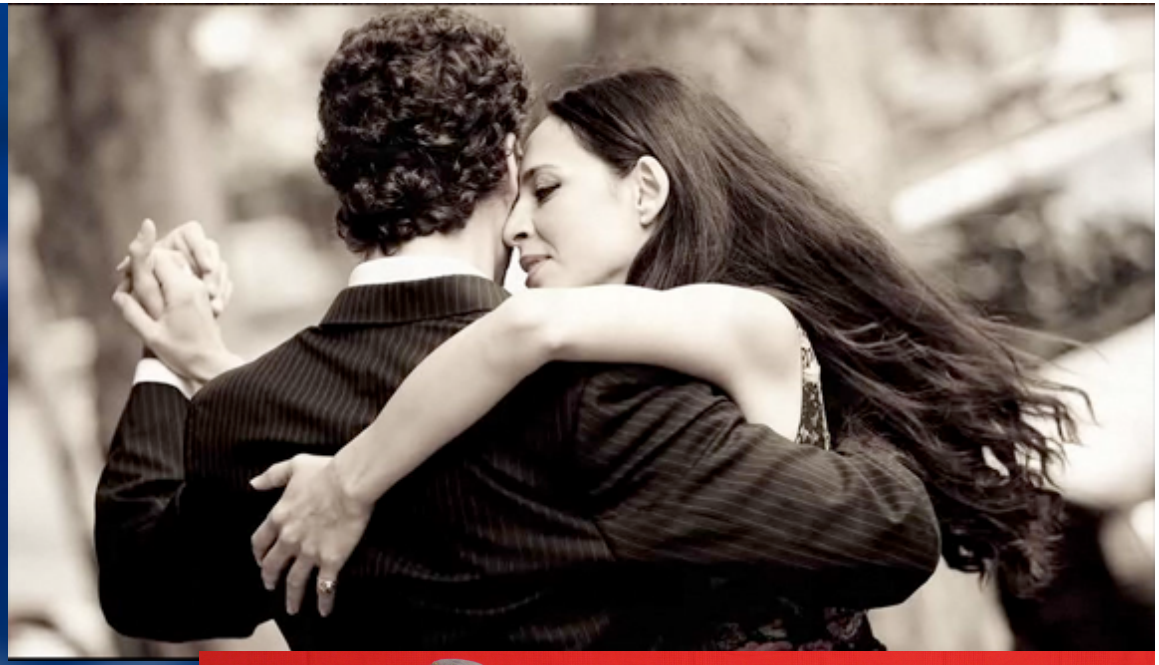
- Maintain good rapport with our students.
- Classroom Assessment (e.g. 1 min papers).
- Cooperative Learning
- Involve people from the community:
  - ✓ Student Conference Day.
  - ✓ Industry-sponsored projects.
  - ✓ Internships / Co-ops / Community Service.
- National Design Competitions


NO SMOKIN
NASA

So, where's the tango in all this ?

- Teacher & student dance together around the subject matter
- Teacher invites – student must accept invitation to the dance
- Teacher leads – student follows during the dance
- It's all about connection (not the steps)
- Student dances w. the subject matter (grapple, question, reflect, etc.)

- Argentine tango
- American tango
- English tango



Take 5 min and think of ways you can implement the 8 conditions in your teaching.

We retain:

- 10 % of what we read
- 20 % of what we hear
- 30 % of what we see
- 50 % of what we both see + hear
- 70% of what we discuss w. others
- 80% of what we experience personally
- 90% of what we say as we do something
- 95% of what we teach someone else

William Glasser
Stice, 1987

What research says about improving undergraduate education – 12 attributes of good practice

AAHE Bulletin, April 1996, pp.5-8

Organizational culture that values:

- High expectations.
- Respect 4 diverse talents & learning styles.
- Emphasis on early years of study.

What research says about improving undergraduate education – 12 attributes of good practice

AAHE Bulletin, April 1996, pp.5-8

Quality curriculum:

4. Coherence in learning.
5. Synthesizing experiences.
6. Ongoing practice of learned skills.
7. Integrating education and experience.

What research says about improving undergraduate education – 12 attributes of good practice

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Quality instruction:

8. Active learning in the classroom.
9. Assessment & prompt feedback.
10. Collaboration.
11. Adequate time on task.
12. Out-of-class contact with faculty.

What Works & What Doesn't

ASEE Prism, Nov. 1995, pp.21-25

What works ***according to Students***:

- Lectures w. anecdotes and examples
- Professors w. mastery of English
- Guest lecturers
- Textbooks w. many examples
- Real-world problems
- HW that includes course projects & teamwork
- Courses in humanities
- Computer assignments
- Tests that focus on methodology

What Works & What Doesn't

ASEE Prism, Nov. 1995, pp.21-25

What doesn't work ***according to Students***:

- Chalk & talk lectures (PP & talk)
- Brilliant researchers who can't communicate
- Isolation from real-world engineering
- Professors who lecture straight from the text
- Plug & chug problems
- HW that's too difficult for most students to complete successfully
- Curriculum that emphasizes only math & science
- Assignments that require timely calculations
- Tests that focus on memorization

What Works & What Doesn't

ASEE Prism, Nov. 1995, pp.21-25

What works ***according to Instructors***:

- Lecturers w. a good sense of humor
- Lecturers w. clear hand-writing, good voice projection, and visual aids
- Classes that emphasize showing students things
- Collaborative textbooks
- Texts w. realistic visuals
- Practical, real-world questions
- Computer programming exercises
- Review sessions before exams
- Exams w. warm-up questions

What Works & What Doesn't

ASEE Prism, Nov. 1995, pp.21-25

What doesn't work ***according to Instructors***:

- Lecturers who talk past the end of class
- Lecturers who write and erase too quickly on the board
- Classes that emphasize telling students things
- Ambiguous exam questions
- Texts w/o examples
- HW or tests w. only theoretical questions
- Dependence on computers for numerical analysis
- Exams that test students on material not covered
- Exams that can't be completed within the time limit.

Reflection

- The most interesting thing you're taking away.
- One thing you're ready to try in your class next week.
- Unanswered questions ?