PBL in Civil Engineering ....

- A peep inside CIVIL @ UL: Philosophy & Ethos
Why PBL?

It is important to note that except for the intelligences that involve symbolic representation and logic, **experiential learning** is fundamental to the learning pedagogy in the creative domain. Musicians cannot learn to perform music without spending a great deal of time actually making music through practice and performance. Dancers cannot develop expertise by simply reading about and critiquing the work of others. Similarly, neurosurgeons do not become skilled through reading alone. They must learn through many hours of personal experience. Even poets learn that all important insights in life do not come from reading the work of others, but rather they often require intense introspection. To develop high proficiency in creative fields requires intense personal engagement, focused practice, and introspection.

Miller 2010
Civil Engineering @ UL

Relatively new
Civil Engineering @ UL

An Experiment

In addition to our own vision ...
Radcliff 2011
Jameson, 2010
Felder 2012
McKeachie & Svinicki, 2006
Mills & Treagust, 2010
Flowers, 2010
Perry 1970
Reddish & Smith, 2010
Wankat & Oreovicz (1993)
Dillon Beach, 1995
Ressler, 2010
Miller, 2010
Develop Hypothesis
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Calibrate instruments
Design & Implement the Experiment
Measure
outcome &
Recalibrate
Traditional Programme

Programme progression
Emerging Paradigm

Programme progression
Change
Civil Engineering @ UL

Takes Time
Compromise
Problem Based Learning

- Learners presented with a problem in advance of having the required knowledge
- Unstructured problem - many feasible solutions – Divergent vs Convergent
- Students work in teams of 5 – 6

CE also use Active learning, Case Studies, Simulation, Experiential learning
Problem Based Learning Process

1. Discussion leader, scribe, time keeper
2. Define unfamiliar terms
3. Brainstorm
4. Develop research plan
5. Undertake independent research
6. Re-convene – go around, share findings
7. Identify new topics or topics requiring further research
   1. This may include requesting learning seminars from staff
8. Iterate to solution
During the Olin Partner Year, many unusual tests were performed. For example, we tested the hypothesis that young engineering students need about two years of preparation in calculus and physics before they are able to undertake the design and construction of a significant engineering device or system. In this experiment, we assigned five recent high school graduates—none of whom had any college courses—the task of designing and building a pulse oximeter, with a time limit of five weeks. In this exercise, the students were first referred to patent literature in the library for a basic schematic diagram and explanation of the purpose and function of the device. They were told that various faculty members may provide advice if asked and otherwise were expected to chart their own course to building the device. The five week time limit was envisioned as providing a convenient reason to end the experiment in the event that the students failed to complete the task, before a post-mortem could be performed.

However, we were surprised to find that the students did not fail as expected, but instead built a functioning device that performed well against a hospital version of the device brought in for calibration at the end of the experiment. We learned two things from this experiment. First, students are indeed capable of completing independent projects of this type with no formal preparation at all in science or math. However, we also observed that the pedagogical effects of this project on the students appeared to be profound. They experienced a sense of exhilaration at exceeding their own expectations and building a device that performed well. This “can do attitude” appears to be an important side effect of the pedagogy of unstructured design projects. It resulted in strong motivation and commitment to completing the educational program and becoming an engineer. From this experiment we developed the sense that, in general, (1) we may be significantly under-estimating the ability of students to learn independently, and (2) this type of student engagement can result in significant changes in attitudes, behaviors, and motivations which are an important outcome in themselves.

Miller, 2010
Can we create a Project to capture the imagination?

November 2009
Trigger

Design an earth berm to protect Thomond Village from flooding.

Additional Information

To cater for predicted water level rises and increased frequency of flooding, the University is constructing an earth berm around the Thomond Village complex. A suitable site has been identified (Figure 1) as a possible source of borrow material for the berm. The design must ensure the berm retains the water without significant seepage losses or failure. Prepare a geotechnical design for the berm.

Two issues have been raised:

1. The buildings office mentioned the possibility of swelling soils on campus and queried if such soils were encountered would they affect the integrity of the berm.

2. Secondly, the client has requested that the development respect the aesthetic and amenity value of the campus park by limiting the height of the berm to 3 m. The design must also include a post construction health and safety plan.

Figure 1: University of Limerick Campus, Plassey, Limerick
No Labs!
Estimate Bearing Stress, \( q \) (kPa) Beneath Dam

- **IF COMPACTED TO A RC = 97%**
  \[ P_{\text{max}} = 1.95 \text{ Mg/m}^3 \]

From Proctor Test Results \( P_{\text{max}} = 1.95 \text{ Mg/m}^3 \)

**Assume Compaction Takes Place at \( w_{\text{opt}} = 12\% \)**

- **Bulk Density** \( \rho = \rho_d (1 + w) \)
  \[ = 1.95 (1 + 0.12) \]
  \[ = 2.184 \text{ Mg/m}^3 \]

- **Unit Weight of compacted soil** \( \gamma = \rho g \)
  \[ = 2.184 \times 9.81 \]
  \[ = 21.43 \text{ kN/m}^3 \]

**Bearing Stress** \( q = \gamma h \)
  \[ = 21.43 \times 5 \text{ m} \]
  \[ \Rightarrow q = 107.12 \text{ kPa} \]

**CHECK \( q \) PRESUMED > \( q \)**

**NOTE:** Be careful when selecting \( q \) presumed – always better to determine from tests.

Check FOS Against Boiling

\[ \text{From Proctor Test } P_{\text{max}} = 1.95 \text{ Mg/m}^3 \]

**Recall** \( P_d = \frac{G_s P_n}{1 + e} \)

\[ \Rightarrow e = \frac{G_s P_n}{P_d} - 1 \]
  \[ \text{TAKE } G_s = 2.70 \]
  \[ = \frac{2.7 \times 1 - 1}{1.95} \]
  \[ = 0.385 \]

**Critical Hydraulic Gradient, \( i_c \)**

\[ i_c = f(G_s, e) \]
  \[ i_c = \frac{G_s - 1}{1 + e} \]
  \[ = \frac{2.7 - 1}{1 + 0.385} \]
  \[ = 1.23 \]

**Exit Hydraulic Gradient, \( i_e \)**

\[ i_e = \frac{\Delta h}{\Delta L} \]

\( \Delta L = 0.2 \text{ m} \) for case with no filter

\[ \Delta h = \frac{H}{N_d} = \frac{4.5}{24} = 0.1875 \text{ m} \]

\[ \Rightarrow i_e = \frac{0.1875}{0.2} = 0.938 \]

**FOS_{boil} = \frac{i_c}{i_e} = 1.23/0.938 = 1.3 NG**

Normally FOS > 5 – use a filter at top.
CIVIL@UL GREY WATER DAM DESIGN
(WITH EXIT FILTER DRAIN)

SEEPAGE LOSS CALCULATION

\[ q = \frac{kH H_f}{H_d} \]
\[ = \left( 2.5 \times 10^{-6} \times 4.5 \times 4 \right) \times 60 \times 60 \times 24 \]
\[ = 1.944 \text{ m}^3/\text{day}/\text{m run} \]
Learning through Failure

One of a number of cases used
FAILURE 1 WK AFTER UNLOADING

80 YRS OLD

74°

INSTALLED 20 YRS BEFORE SALT UNLOADING

REZAR 'PREZAR'

"V STRAIN" "N STRAIN"

SOFT SOFT
Prepare Expert Reports for Defence & Plaintiff - exchange
Proceedings Video Recorded

Videos uploaded to Sulis for review
What the students said …

I have learnt a lot about teamwork during my time here but this project took it to the next level and was a real eye opener for me.

This time however our team consisted of law students who had no previous experience with building materials such as concrete and the issues associated with it and similarly I had very little knowledge of the legal issues within the project which had to be addressed. It required a much greater effort than I first anticipated explaining my research and technical findings on the case but I now realise I must take my audience and their backgrounds into consideration when trying to convey technical information and choose appropriate language to facilitate understanding and meaningful communication.

Looking back on the last twelve weeks of Forensic Engineering I can honestly say I enjoyed the module and found myself looking forward to the lectures.

I found the case studies very interesting. Sometimes while doing other project work or FYP work, if I found myself getting bogged down or needing a break I found myself looking up the case studies and having a read.
What
if
What if ...?