Physics and Low Mathematics: Approaches for First Year Engineering and Science Students

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- **Pathway diplomas:**

  provide entry to second year in the Faculties of Science and Engineering at the University of Technology, Sydney (UTS).

- **Our students:**

  have very diverse backgrounds with a wide range of mathematics knowledge.

- **Mathematics:**

  is not a pre-requisite, thus teaching physics to these students is challenging.

What to do?

- **First step approach:**

  non-calculus physics is taught requiring mathematical knowledge at about advanced Year 10 level.

- **Difficulties :**

  1. Some lack basic algebra, graphing, trigonometry and even arithmetic skills.

  2. Some lack study skills.

  3. Some lack responsibility toward study.

Physics : Initiatives Implemented

1. Pre-commitment questions during the first lecture

2. 'Challenge problems' given at the end of each lecture

3. Conceptual online homework assignments

4. Form style laboratory sheets

Pre-commitment Questions

- **Objectives:**

1. Record lecture attendance.
2. Highlight the time needed to absorb the material.
3. Put the responsibility on the students to get help with their mathematics if necessary.

Name:_____

Student Number:_____

1. How many hours of study a week are necessary to pass Physical Modelling?

2. How many hours a week will you invest in order to pass Physical Modelling this semester?

3. Do you feel you have the required maths (see lecture slide 6) required to pass this subject? Weak maths is a major disadvantage in this subject. Get help, starting week 1, if you have ANY difficulties with the maths used.

Pre-commitment Questions

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- **Surprising Outcomes:**

1. 22/ 89 attendees for the first lecture acknowledged poor mathematics knowledge.

2. Of these, 5 dropped the subject to work on mathematics, 10 passed, 7 failed (most repeats).

3. 7 of those 10 passed with credit +, including 4 HDs in this group.

4. Overall pass rate in the subject last semester ~60 %, compared to the semester average ~ 50 %.

Real improvement? Time will tell.

Challenge Questions

- Given at the end of each lecture

- **Objectives :**
  - to encourage lecture participation.

  - to provide early feedback to the students on their abilities (*walk around and help*)!

  - to show students level expected of them (*taken from semester 2 final and it is TIMED)*.

Student Feedback: 'Really good Miss.
Now I know I need to do more work.'

Real improvement? Time will tell.

Name:_____

Student Number:_____

You are camping with two friends, Joe and Karl. Since all three of you like your privacy, you don't pitch your tents close together. Joe's tent is 21.0 m from yours, in the direction 23.0^{o} south of east. Karl's tent is 32.0 m from yours, in the direction 37.0^{o} north of east.

a) What is the **distance** between Karl's tent and Joe's tent?

b) What would your **velocity** be (**magnitude and direction**) if you walked from your tent to Joe's and then to Karl's tent in 30 seconds?

Hint: Draw a diagram. You can write your answer on the back of this sheet. Keep it neat!

Conceptual Online homework assignments

- **Objectives:**
  - to assist focus on physics theory
  - to engage students in the manipulation of the equations.

- **Question types:**
  - **not simply 'plug numbers' into an equation.**
  - all questions were chosen to be full algebra/ trigonometry using pro-numerals.
  - all questions chosen had 'hints' available for the student when stuck on a concept.

Conceptual Online homework assignments

- **Problems:**
  - very little randomization.
  - easy to cheat in online assignments.

- **Outcome:**

  EXAM MARK (E) vs TIME INVESTED IN MINUTES PER WEEK (T).

Numeric type questions (2010 S2)	**Pro-numeral type questions (2013 S3)**
Positive linear correlation. [r = 0.37, n = 45, p = 0.012] E = 0.36 T	Positive linear correlation. [r=0.39, n = 127, p = 0.000] E = 0.55 T

- **Real improvement?** Time will tell.

Form Style Laboratory Sheets

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- **Objectives:**
  - to improve data handling and analysis.
  - to encourage (force) the students to do every step in the data analysis (rather than a half hearted effort).
- **Why?**

Most cannot do averages, draw graphs, calculate the gradient of a straight line or work out fractional errors.

- **Outcomes:**

-By the end of last semester most could calculate averages, draw graphs and calculate gradients.
- Some mastered fractional error analysis.

Real improvement? Time will tell.