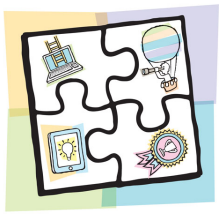

Case Study L: Using Examination Data Analysis Forms to Implement Year-on-Year Module Improvements

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Module discipline: Biomedical Engineering
Approximate module size: 40-70 students
Level of module: Final (4th) Year

Reasons for using analytics in the module

As programme director for the BE degree in Biomedical Engineering I require that all module coordinators complete an Examination Data Analysis Form (example shown below).

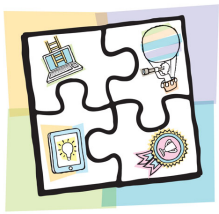
- The form requires systematic analysis of student performance in each question of an exam.
- Common errors and learning difficulties are revealed through data analysis.
- Methods to overcome identified learning difficulties must be suggested and implemented in subsequent module delivery.

This system ensures that lecturers implement year-on-year improvements of module delivery and examination based on data analysis of student performance. Data analysis sheets are made available to the Programme External Examiner for review.

Data sources/modelling approach

Below is a sample Examination Data Analysis Form

EXAMINATION DATA ANALYSIS FORM, 2014			
Module Code:	BME400		
Module Title:	Biomechanics		
Credits:	5		
Module Co-ordinator	Dr. Patrick McGarry		
	Comments on individual questions in which students' performance could have been improved and suggested strategies for improving performance in the future	No students attempted	Average Score (/25)
Q1	***Common errors:*** Students had difficulty deriving general solution (Part B). Students had difficulty deriving solution for a constant outflow from ventricle during systole (Part C)	42	12.4



	Suggestions: Students required to perform calculation for constant systolic ventricular outflow as part of lab next year.		
Q2	***Common errors:*** Students had difficulty with reproducing graph for Casson's equation. Students had difficulty in outlining the limitations/applicability of the solution given in Part (e). ***Suggestions:*** Provide tutorial with graphical measurement relating to Casson's equation. Highlight limitations/assumptions for flow equations.	42	14.4
Q3	***Common errors:*** Students had difficulty in determining the muscle shortening velocity that produces maximum power. ***Suggestions:*** Worked examples on Hill law and power output, and perhaps a demonstration using a rowing machine with variable resistance and power output.	40	11.7
Q4	***Common errors:*** Question well answered but some students careless with units. ***Suggestions:*** Question relates strongly to bone laboratory calculations. Insist on use of consistent units in lab report.	42	13.2

Overall average marks for module:

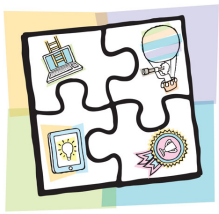
The overall average for the module is 56% (The average exam grade is 54%. The average grade for module labs/projects is 62%. Module weighting is 70% for exam and 30% for labs/projects).

Insights obtained from data analysis:

The exam was challenging and extensive in its scope; the majority of students displayed that they had studied the lecture material in great detail and displayed a good understanding of fundamental biomechanical principles. Of the 42 students taking the module the breakdown in grades is as follows: 11xA, 9xB, 9xC, 7xD, 2xE, 4xF. The majority of students receiving an E or F grade did not engage with the module, failing to submit labs/projects. A new exam format was introduced this year, moving to a 2 hour 4 question paper, where students were required to attempt all questions (previous years entailed a three hour exam with students required to attempt five of six questions). This new format did not have a negative effect on average/above average students, but it did seem to expose weaker students (higher percentage of fail grades (E,F) than previous year).

Insights obtained from student feedback:

Student feedback for module was extremely positive and students and lecture attendance was consistently high during the module. Students generally commented that the material covered in the module was interesting, highly relevant and challenging. Students also



commented that the labs/projects (bone mechanics lab, aorta compliance lab, stent analysis project) were very helpful in understanding the material and theory covered in lectures.

Impact of using data

As an example of the impact of this approach, data analysis of Q3 (on the topic of muscle mechanics) on the exam revealed the following:

"Common errors: Students had difficulty in determining the muscle shortening velocity that produces maximum power."

The template requires the proposal of an action to overcome this identified learning difficulty:

"Suggestions: Worked examples on Hill law and power output, and perhaps a demonstration using a rowing machine with variable resistance and power output."

Based on this analysis when lecturing on muscle mechanics I bring five student volunteers from the class to the university gym prior to the first lecture on the topic (conveniently this is next-door to the engineering building). Using a biceps curl machine we take measurements of lifting speed for a range of weights. Also, using an exercise bike we measure the power generated for a range or resistances (bicycle gears). I record videos of the students' efforts which I then show the whole class at the start of the next lecture (and of course no training montage is complete without the Rocky theme music!). Using interactive handouts and real-time problem solving on the white board, I take the class on a journey through the engineering calculus and chemical kinetics that describe muscle behaviour, ultimately demonstrating that the measurements that we take in the gym can be precisely predicted by the theoretical equations.

This interactive and fun exercise is highly successful in engaging the students and provides an interactive teaching methodology that assists students in relating the complex differential equations that describe muscle behaviour to analysis of motion and sporting performance.

Based on my modifications to my teaching approach motivated by data analysis of the module examination the average mark in the muscle mechanics question on the 2016 exam paper increased to 16.1/25 (compared to 11.7/25 in the 2014 exam paper above), despite the fact that the question set in 2016 was more mathematically challenging that the question set in 2014.