Coming to Grips with Energy Systems

G.P.Grodzicki
University of Western Sydney, Sydney, Australia, g.grodzicki@uws.edu.au.

Abstract

At UWS, the School of Engineering offers energy systems units at undergraduate and postgraduate courses. The energy systems units encompassed an introduction to electric power systems under normal and abnormal operating conditions, along with an introduction to power electronics. Delivery was via the usual lecture, laboratory and practical but with emphasis on continuous assessment through multiple choice homework questions and through three short quizzes, also multiple choice, spread throughout the teaching session of 14 weeks. Content was adapted over the four years from 2008 to 2010 in line with recommendations by the accrediting body, Engineers Australia. In 2010 there was also a shift to criteria based assessment. In 2008 concept maps were introduced to assist learning. Instead of handing out solutions to set tutorial problems, the concept map was used to guide the students to solutions. In this way the students would have to interpret the concept map, with some even preferring to create their own, and to produce a quantified solution on their own; the resulting solution would be one that the students would feel they had complete ownership over. At the end of the 2008 teaching session, the feedback from students in that year ranged from 3.4 to 4.4 in a rating scale out of 5. In later years the emphasis on the use of the concept map was much less and the ratings in the student feedback on units was also found to be lower. Whether or not it was just the peculiarity of the cohorts is not clear. This paper provides more detail of developments and proposed future iterations.

1. Introduction

The University of Western Sydney is a multi-campus university located in the Greater Western Region of Sydney. Students complete degree courses accredited by Engineers Australia; accredited courses allow graduate entry into Engineers Australia. Specific graduate attributes are specified by Engineers Australia, as well as the university itself, which should be observable on graduation. For example, one of the Engineers Australia graduate attributes is “in depth technical competence in at least one engineering discipline.” Similarly the UWS graduate attribute includes “has in-depth knowledge of one or more chosen fields of study”. The students’ studies of energy systems assist in achieving such graduate attributes.

As part of the degree program an energy systems unit is offered at the undergraduate and postgraduate level. The undergraduate unit encompasses an introduction to power systems under normal and abnormal operating conditions, along with studies in power electronics.

2. Delivery & Assessment

At UWS, one of the teaching periods is a “session” (or semester) which is comprised of 14 weeks of instruction. The equivalent full time student load, or EFTSL, is comprised of 4 units, each weighted at 10 credit points each. The Energy Systems unit was weighted 10 credit points. The content of the Energy Systems unit was delivered via the usual mix of lectures, tutorials and practicals. The lectures would be allocated 2 hours per week; the tutorials 1 hour per week and the practicals 2 hours per week. This meant 5 contact hours per week for the students, requiring the student to complete another 5 hours in independent study. In the original design of the degree program, the number of hours to cover the instruction material was 40 hours per week, equivalent to the old working week. The full time student has thus agreed to put in 40 hours of study per week. Given the necessity for paid work, the hours of independent study are not fully realized.

The assessments are divided up in such a manner as to try to encourage continuous learning. Anecdotal evidence through discussions with cohorts of students indicated that many would develop the habit of cruising along during the session and trying to catch up during the study vacation, typically not resulting in optimum grades. Following numerous reviews, continuous style assessments were introduced, specifically, weekly home-works and three quizzes. The home-works would consist of 5 multiple choice questions, posted up during the current week, with the answers being due at the start of the next lecture. The quizzes would similarly consist of 15 multiple choice questions, 3 times per session. The motivation here was to encourage the cohort to keep up with the material and to reward those who did through better grades. Observations of student behaviour showed this to be working; students would be diligent in the completion of the assessment tasks. Full statistical results, giving average, standard deviations, and modal marks were made available shortly after the home-works were submitted and the quizzes completed. This was intended to supply timely feedback.

The practicals consisted of physical laboratory tasks in any given week and simulations every other week. With the trend to the use of more simulations, this adoption of a mix of physical and computer tasks was considered preferable to all simulation tasks. The "hands on" experiences the students acquired through physical laboratory work has always been considered paramount in the School of Engineering and originated with the "foundation dean of the engineering faculty".

3. Student Responses

As part of the gathering of feedback from the cohort, Student Feedback on Units or SFUs is used once a session. These consist of 13 questions with answers via a one of 5 ratings: Strongly Disagree (1), Agree, Neutral, Disagree and Strongly Disagree (5). The University sets a target of 3.8/5; ratings of 3.5 or less earmark the unit for special attention [1]. Typical SFU results are shown in Figure 1. Clearly some changes to the unit were needed in order to achieve the target set by the University's administration.

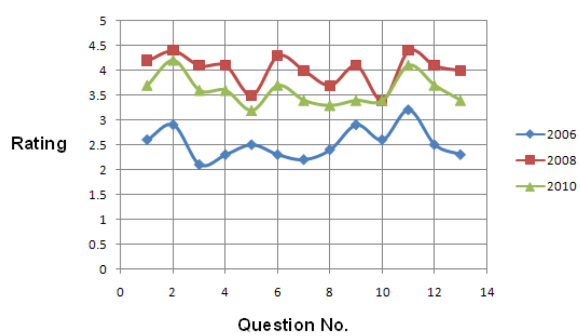

Figure 1: SFU ratings

The 13 questions asked ranged from "The unit covered what the unit outline said it would (Q1)" to "I was able to learn from feedback I received in this unit (Q5)" to "Overall I've had a satisfactory experience in this unit (Q13)". Changes were affected over the years to attempt to improve the performance of the unit as perceived by the cohorts. A common criticism was the scope of the material in the unit and the pace of delivery. In particular, the students were asked to rate the extent to which "The amount of work required in this unit was reasonable". This still seems to be a low point in the surveys.

There was a mixture of power systems and power electronics initially in the scope of the unit. A review by the accreditation body, Engineers Australia, recommended that the power electronics aspects be removed and treated on its own elsewhere, leaving the unit with an emphasis on power systems and renewable energy sources, the latter of necessity requiring some exposure to power electronics. One of the comments received from the students was that in the earlier version, with some 50% devoted to the study of power electronics and 50% to power systems, the unit felt like two subjects in one.

As is the case often with student surveys, contradictory comments are made by the students. So for example one comment might rate the multiple choice assessments as a best aspect while another would rate it "needs improvement". The 13 questions answered are not sufficient to allow further discernment, so some amount of interpolation becomes needed. Some comments stated the physical practicals were helpful while other comments rated them too long or too involved.

3. Getting Involved

Reflecting on the results pointed out the need to involve the student more than was presently the case, bearing in mind the demands overall of a full time load. Students would comment that more fully worked solutions were needed. The difficulty here with respect to teaching and learning was that a worked solution made the problem seem easier than it was in reality; it could mislead the student into thinking that understanding was there all along but some small aspect prevented the correct answer being found the first time. So a better scheme might be to meet the student half way.

The adoption of a concept map seemed to have the answer as to the change needed in this regard. The idea was that the map would not be a fully worked solution but a means to getting to the solution with some independent study. Intermediate and final numerical values would appear but the detailed steps would be implied. The student would use the relationships between the various concepts to work out the full solution. The tutorials would be there as backup for any questions the students might have along the way. This was the system adopted in the 2008 delivery possibly one of the reasons for the higher SFU ratings that year, as shown in Figure 1. A typical concept map as made available to the 2008 cohort is shown in Figure 2.

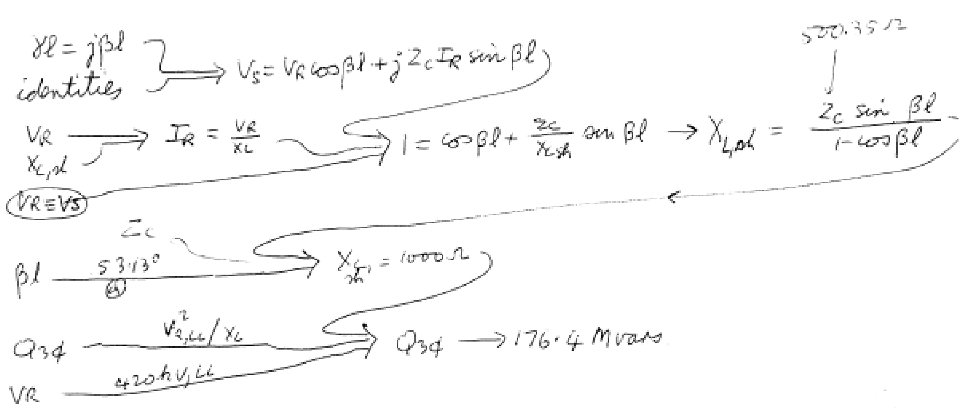

Figure 2: Typical concept map.

It was interesting that one comment made was that the “unit developed problem solving skills, to be able to do this independently”; one would most likely correlate this with the use of the concept maps. Other comments stated the concept maps given out were not as optimum as they could be, and that the concept map developed by the student was superior. The motivation behind the concept map was to try to achieve just this kind of development; the student has developed his own solution, his own concept map, and so has taken ownership of the solution, now regarded as he/her own work.

In later iterations of the unit, as in the 2009 and 2010 deliveries, less emphasis was placed on the use of the concept maps. The SFU ratings were lower in the years of those iterations. Possibly this is a strong argument for a return to the use of the concept map. Along with a reduced emphasis on the concept map, the unit introduced, for the first time, criteria based assessment in 2010.

Assessment based on criteria required the adoption of two new documents to be available to the student. The “Unit Outline” would be handed out, and would comprise an overall description that would be brief. The full details would appear in the “Learning Guide”, which would describe the criteria that would be used to gauge the student’s performance along with the set assessment tasks, etc. Adjustment to this method of assessment is still underway.

4. Quantifiable Effects

As a second method of quantifying the changes made over the years, as a measure of unit performance, the “effect size” or standardized mean difference, was selected as a parameter with which to make comparisons. The effect size estimate provides an easily interpretable value on the direction and magnitude on methods used between 2 groups. “Effect size”, or *d* value, is a simple means of quantifying the size of any difference between groups [2] [3]. The effect size is calculated by dividing the difference between the means by the pooled standard deviation. An effect size $d = 0.2$ indicates little separation between groups with a lot of overlap; an effect size $d = 0.5$ indicates moderate effect, with some separation and a lot of overlap. A value of $d = 0.8$ would indicate a large effect, lots of separation, still with overlap. The optimum effect size would be $d = 2.0$.

Looking at the data for 2008 and 2010, and selecting 2010 the control, the effect size is shown in Table 1. Interpreting the effect size in terms of percent of non-overlap of the two survey results, the value of 1.4 indicates some a non-overlap of 68% in the two sets of ratings [4].

Table 1: Effect Size

Year	Group size	ES
2008	21	1.4
2010	21	Control

5. Conclusion

AS one of the major differences in the presentation of the undergraduate Energy Systems unit, the use of the concept map seem to elicit the most favourable responses from the student cohort of 2008. In deliveries where less emphasis was placed on the use of the concept map as a means of developing solutions to tutorial problems, SFU responses were less favourable. There seems to be strong evidence for another serious trial of the concept map in deliveries. To what extent the characteristics of the particular year’s cohort influenced results remains unclear.

As shown in the student survey responses in Figure1, two problems are indicated in the responses to Questions 5 and 10. The former pertains to the amount of feedback received by the students; it appears the timely availability of test results via Blackboard is not enough. The latter refers to "the amount of work" demanded by the unit; it seems some more changes are in order. Changes will be made in the next iteration planned for Spring, 2011.

References

1. University of Western Sydney, "UWS AUQA Performance Portfolio, February 2011". University of Western Sydney, February, 2011.

2. R.Coe, "It's the Effect Size, Stupid - What effect size is and why it is important" Conference *of the British Educational research Association, University of Exeter, England, September, 2002. Available at http://www.leeds.ac.uk/educol/documents/00002182.htm*

3. J. A. Colliver "Effectiveness of Problem-based Learning Curricula: Research and Theory", *Academic Medicine,* Vol. 75, No. 3 / March 2000, pp. 259-266.

4. L. A. Becker, "Effect Size", 2000.
   Available at: *http://web.uccs.edu/lbecker/Psy590/es.htm*