Assessing-to-learn; enriching the assessment process

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Abstract ¾ *Assessment has a profound effect on learning - it focuses the students' attention and actively encourages out-of-class engagement with the learning resources. Indeed it is repeatedly quoted as being the single most important activity with respect to encouraging learning. Further, in engineering disciplines the class-room activities (often) only appear to come alive when students are exposed to laboratory or hands-on activities. Coupling these notions together generally brings the need for students to produce formal laboratory reports. For the busy lecturer the marking of such reports, particularly as student numbers continue to grow, brings time demands that often conflicts with recognised good practice in terms of the quality and timing of the feedback. This work presents the findings from an alternative assessment approach which seeks to maintain the laboratory provision but uses the students, as well as desktop technology, to both help the assessment process as well as to enrich the learning opportunities. The paper draws out some of the opportunities and identifies the possible pitfalls of this approach. The findings have already indicated the merits of the approach hence this paper is likely to be of immense value to colleagues interested in i) developing learners and ii) engaging with experiential learning.*

Index Terms — *Peer assessment, laboratory studies, computer assisted assessment*.

BACKGROUND

There can be little doubt that assessment forms a significant role in the learning process [1]. Whilst good assessment should be aligned with the module learning outcomes, (constructive alignment), it should also seek to challenge, stimulate and give opportunities for the students to take away both *situated* and *abstracted* cognition. Accepting that a well considered assessment will actively drive (appropriate) *learning* it is also true that even a poorly contsructed assessment will, at the very least, drive student *activity*. Natually it is acknowledged here that student *learning* and *activity* are not mutually inclusive. Whilst the former, student learning, is the preferred model both experiences are presented because they show the importance of assessment on student behaviours. Such issues, the impact of assessment on the learners, together with the fact that assessment carries some backwash i.e. it may inadvertently indicate to the students *what aspects of the curriculum are important and which are not* as well as h*ow much time they need to spending on out-of-class activites* [2,3]. Whilst the students perceptions of such issues may be very different from those of their teachers' they are all features of assessment backwash and hence again, need to be recognised by the assessor.

Whilst the *Seven Principles for good practice in undergradute education* [4] refers to the importance of *feedback* and *time-on-task* an emerging evaluative instrument on assessment, the *Assessment Experience Questionnaire* (AEQ) [5], looks a little closer at a range of components associated with of assessment. Naturally the AEQ also includes *prompt feedback* and *distributing the student time and effort* but covers other features such as the *focus of the feedback* (learning not marks) and the fact that the *feedback should be attended to by the students*. Since these instruments form an appropriate backdrop for the work presented here, the *Seven Principles*… and details of the *AEQ* are presented in table 1 and table 2 below.

Principle	Good practice…
1	… encourages contacts between students and faculty
2	… develops reciprocity and cooperation among students
3	… uses active learning techniques
4	… gives prompt feedback
5	… emphasises time-on-task
6	… communicates high expectations
7	… respects diverse talents and ways of learning

TABLE 1
SEVEN PRINCIPLES OF GOOD PRACTICE IN UNDERGRADUATE EDUCATION.

Theme of the AEQ	Conditions of the AEQ.
Time demands and student effort	Assessed tasks capture sufficient study time and effort These tasks distribute student effort evenly across topics and weeks
Assignments and learning	These tasks engage students in productive learning activity Assessment communicates clear and high expectations to the students
Quantity and timing of learning	Sufficient feedback is provided, both often enough and in enough detail The feedback is provided quickly enough to be useful to students
Quality of feedback	Feedback focuses on learning rather than on marks or students themselves Feedback is linked to the purpose of the assignment and to criteria Feedback is understandable to students, given their sophistication
Use of feedback	Feedback is received by students and attended to Feedback is acted upon by students to improve their work or learning

TABLE 2
CONDITIONS OF THE ASSESSMENT EXPERIENCE QUESTIONNAIRE.

Even accepting the ideals noted above, most conventional approaches to assessment are often too closed with the students firmly adopting the role of the learner and the teacher adopting the assessor role. Such classic positions, learner or teacher, may reduce the learning opportunities since

- students may be a little too remote from the assessment criteria
- good and bad submissions are often only seen by the teacher and the student that actually submitted the work.

Reconciling these additional issues may provide additional enhanced learning opportunities. Whilst this introductory preamble is relevant for all disciplines, in many engineering degree programmes laboratory studies also form an integral part of the assessment diet. These are valuable experiential learning opportunities, give students hands-on experiences and often allow a more relaxed opportunity for students to explore what-if studies. The downside to providing such opportunities is the fact laboratory studies traditionally conclude with a formal laboratory report. For the busy lecturer such reports bring additional time demands.

This work does not report on our use of laboratory studies but on a novel approach that uses the students as assessors of the formal laboratory submissions. The motivation for adopting this assessment approach was simple; it sought to enrich the learning process. This was undertaken by -

- Building on the learning opportunities of assessment
- Bringing the learners closer to the assessment process
- Letting the learners see how others tackle the same task
- Reducing staff marking time

For reference this work was applied to three separate modules. The materials and methods used/developed as well as collective findings are presented.

MATERIALS AND METHODS

The starting point for this work is the delivery of briefing sheets that allow the students to see the requirements of the assessment. In this instance it included a standard *coursework briefing sheet*. This sets out the rules of engagement (*hand-out, hand-in dates*), information on the submission requirements (*…a formal individualised laboratory report describing…*) as well as indicating the expected learning outcomes. In addition to the coursework briefing sheet the students were also provided with a report writing guide '*An introduction to writing good laboratory reports'*. This included information on the expected structure of the report, (*abstract, … conclusion, tables need numbers and titles)*, as well as information on the *purpose* and *role* of each section. Both documents were then used by the staff to construct appropriate marking criteria. Although variations existed for the three modules, typically a ~50 question questionnaire was developed. The questionnaires were focused around the expected content and presentation from each study. Whilst there was much natural overlap in the questionnaires, for the three modules they were only used to assess laboratory reports, there were also unique questions that specifically focused on the task-in-hand. For reference some questions required only binary responses, (*yes/no),* whereas others gave opportunities for graded responses (*a-e*). The use of a formal questionnaire was used to help provide standard marking criteria and reduce some of the marking subjectivity. These questionnaires were, after-all, to be used by the students.

The marking questionnaires were used alongside standard optical marking sheets. This allowed automated reading of the marking-data and ease of transference of data to Microsoft Excel. The use of a spreadsheet allowed the teachers to set up marking rules which allowed automated marking and automated selection of appropriate studied unique feedback. The culmination of which being an automatically generated and delivered student-unique e-mail. The feedback focused on the task and gave either positive text regarding the response to each question as well as text that gave opportunities to improve. i.e. In addition to being prompt, the feedback focused more on learning than marks. Examples of these instruments are given in figures 1-3.

An introduction to writing laboratory reports.
Version 2.0 Jan '05
Mark Russell

An introduction into writing laboratory reports

1.0 Preamble.

Laboratory studies are an integral feature of your engineering degree. They reinforce the learning and provide a practical experience that supports your academic/class based studies. Hence they are of immense value. To maximise the learning experience you will often be expected to report on the outcomes of the laboratory exercise via a formal laboratory report. The purpose of **this document**, therefore, is to introduce or re-enforce some features that a good laboratory will comprise. Whilst it is acknowledged that some of you may already be familiar with a laboratory report, experience has shown that many of you are not.

It should also be noted that these notes contain generic guidance that may help improve your written submissions in other areas of your studies e.g. non laboratory based. It is, therefore, vitally important that your read these notes carefully and take from them the issues raised.

Before introducing the format it is important to note that technical reports should always be written in the third person. For instance, you should avoid writing –

i) *"... I set up the apparatus as shown in figure 1 ... "*
ii) *"... We took measurements at 30 second intervals ... "*

Better is –

i) *"... The apparatus was set up as shown in figure 1 ... "*
ii) *"... Measurements were recorded at 30 second intervals ... "*

2.0 Report format.

Although engineering students are frequently required to write laboratory reports, there are many different ways of presenting them. Further, it is also likely that different lecturers have different expectations of what a good laboratory looks like. Accepting this potential conflict, it is, however, possible to identify generic guidance on the type of features that most lecturers will expect in a report. Consider carefully the guidance given in this document and you are likely to satisfy many of the (varied) demands placed on you.

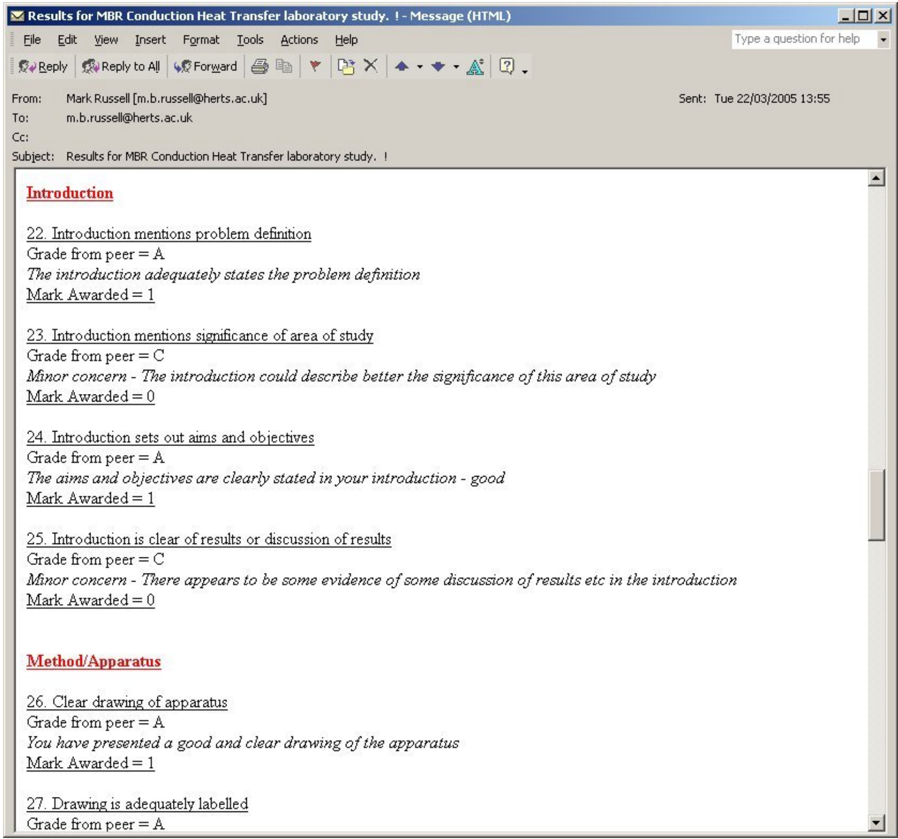
3.0 Contents of a laboratory report.

FIGURE 1
SAMPLE SCREEN-SHOT OF THE GUIDE ' *AN INTRODUCTION TO WRITING LABORATORY REPORTS'*

Assessment criteria to be used for peer assessment of lab reports

Report Structure					
1	The report has a title that reflects the contents of the laboratory study	A		E	A = Yes, E = No
2	The front page presents a simple and effective cover sheet	A		E	A = Yes, E = No
3	The report has a section at the start titled abstract/summary (or something similar)	A		E	A = Yes, E = No
4	The report has a section named introduction (or something similar)	A		E	A = Yes, E = No
5	The report has a section named method/apparatus or something similar	A		E	A = Yes, E = No
6	The report has a section named results (or something similar)	A		E	A = Yes, E = No
7	The report has a section named discussion (or something similar)	A		E	A = Yes, E = No
8	The report have a section named conclusions (or something similar)	A		E	A = Yes, E = No
Presentation - Now take a quick flick through the reports.					
9	The graphs of results are only present in the results section	A		E	A = Yes, E = No
10	The graphs are given figure numbers	A	C	E	A = All, C = some missing, E = none
11	The graphs are given appropriate titles	A	C	E	A = All, C = some missing, E = none
12	The graphs have axes that are labelled	A	C	E	A = All, C = some missing, E = none
13	The scaling of the axes on the graphs seems appropriate. i.e. is the data is fairly central within the graph	A	C	E	A = All, C = some are not, E = none
14	The axes of the graphs carry the units of the variable being denoted	A	C	E	A = All, C = some missing, E = none
15	The tables of results are only carried in the results section	A		E	A = Yes, E = No
16	The tables are numbered	A	C	E	A = All, C = some missing, E = none
17	The tables are given appropriate titles	A	C	E	A = All, C = some missing, E = none
18	The name of the variable(s) being shown in the tables is denoted	A	C	E	A = All, C = some missing, E = none noted
19	The units of the variables presented in the tables are given	A	C	E	A = All, C = some missing, E = none noted
Summary/abstract					
20	The abstract appears to provide a miniaturised version of the whole lab report - including key findings etc.	A	C	E	A=Good, C = Fair, E = Poor
21	The abstract for this report seems to be about the right length. i.e. less than half and A4 sheet	A		E	A = Yes, E = No
Introduction					
22	The introduction section mentions the problem definition. i.e. what it is that is being studied	A	C	E	A=definitely, C = sort of, E = not at all
23	The introduction section mentions the significance of the problem definition. i.e. why study this area	A	C	E	A=definitely, C = sort of, E = not at all
24	The introduction explicitly sets out the aims and objectives of the experiment	A	C	E	A=definitely, C = sort of, E = not at all
25	The introduction is completely clear of any results or discussions/conclusions about the actual experiment.	A	C	E	A=Mostly clear, C = minor references to results, E = lots of reference to results
Method/Apparatus					
26	There is a clear drawing of the apparatus	A	C	E	A = Clear drawing, C = clumsy drg, E = No drawing
27	The apparatus drawing is labelled identifying the major individual parts	A	C	E	A = Clear drawing, C = clumsy drg, E = No drawing
28	The apparatus drawing is given a figure number	A		E	A = Yes, E = No
29	The apparatus drawing is given a title	A		E	A = Yes, E = No
30	The method section describes a procedure that would allow this experiment to be repeated	A	C	E	A=definitely, C = sort of, E = not at all
Results					
31	The results section carries the raw results data	A		E	A = Yes, E = No
32	The results section also carries calculations or the outcome of calculations based on the raw data	A		E	A = Yes, E = No

FIGURE 2
SAMPLE SCREEN-SHOT OF THE MARKING-QUESTIONNAIRE



Results for MBR Conduction Heat Transfer laboratory study. ! - Message (HTML)

From: Mark Russell [m.b.russell@herts.ac.uk]
Sent: Tue 22/03/2005 13:55
To: m.b.russell@herts.ac.uk
Cc:
Subject: Results for MBR Conduction Heat Transfer laboratory study. !

Introduction

22. Introduction mentions problem definition
Grade from peer = A
The introduction adequately states the problem definition
Mark Awarded = 1

23. Introduction mentions significance of area of study
Grade from peer = C
Minor concern - The introduction could describe better the significance of this area of study
Mark Awarded = 0

24. Introduction sets out aims and objectives
Grade from peer = A
The aims and objectives are clearly stated in your introduction - good
Mark Awarded = 1

25. Introduction is clear of results or discussion of results
Grade from peer = C
Minor concern - There appears to be some evidence of some discussion of results etc in the introduction
Mark Awarded = 0

Method/Apparatus

26. Clear drawing of apparatus
Grade from peer = A
You have presented a good and clear drawing of the apparatus
Mark Awarded = 1

27. Drawing is adequately labelled
Grade from peer = A

FIGURE 3
SAMPLE SCREEN-SHOT OF A TYPICAL FEED-BACK E-MAIL

ADDITIONAL FEATURES

In addition to the previously described marking instruments other, computer based technologies were used to help in the assessment process. Both were used to plugged perceive gaps that arise from this peer assessment process. First, because this approach does not use a control assessor, (i.e. it uses many rather than one set of eyes) it may have been easier for students to pass plagiarised work off as their own. This potential gap was plugged by requiring the students to submit an electronic copy of their report which was subsequently passed through a plagiarism checker. Thus although many assessors were working in parallel a centralised facility was used to check for plagiarism.

Second, in addition to marking the work provided in the laboratory report, the students were also required to submit their raw laboratory data, as well as calculations based on this data. This was submitted to software written specifically written to take this student data. Having submitted the data, additional features were developed to automatically mark and provide a second student-unique feed-back e-mail. This aspect of the assessment programme checked the validity of the data and the student numerical results. In doing so it focused on the numerical correctness of the students work and not the presentation in the report. A discusion on this automated approach to assessment can be found in [6].

RESULTS

At this stage it is not possible to report back on the long term benefits of this process - detailed analysis of the students' follow-up laboratory reports is not yet possible. Even without this follow-up analysis, it is still believed that this work has already been useful. Students have asked if all reports should be structured like this as well as asking to keep the marking criteria. Further, discussions with the students have also received encouraging responses. These encouraging responses are reasonably well quantified by the response to the last question in the questionnaire. In response to the question I have learnt a lot from this marking exercise the following results were found

	++	+	0	-	--
M1	35	60	16	1	4
M2	15	29	16	7	9
M3	5	31	21	8	6
∑	55	120	53	16	19

TABLE 3
STUDENT RESPONSES TO 'I HAVE LEARNT A LOT FROM THIS EXERCISE'

Legend for table 3
M1 = Fluid Mechanics and Thermodynamics
M2 = Simulation and Analysis Techniques
M3 = Aero-thermodynamics and Design
++ = strongly agree
+ = agree
0 = neither agree nor disagree
- = disagree
-- = strongly disagree

A summation of the positive responses, i.e. ++ or + shows that 175 students from the 297 total (~59%) thought this was a worthwhile exercise. This compares with only 69/297 (~23%) that did not. The rest, 53/297 (~18%) indicated a neutral response.

Although follow-up work has not yet been collected what is also immediately useful from the data collection is the ability to interrogate the marking data and look for generalised findings. i.e. which aspect of the report was written well and which was written less well. Which features of the study were well understood and which requires follow-up help. Such evidenced-based diagnoses-of-learning may have been difficult without such a process.

In undertaking this study other opportunities emerge to establish the students' views of what they read. After the marking was completed a ***good, bad and ugly*** discussion forum thread was started in the module specific area of the Universities Managed Learning Environment - *StudyNet*. This sought to seek the students' views, not of the process, but of what they saw and read. This additional sharing opportunity which required the students to reflect on what they read, allowed others to see some of the good, as well as less good, features of the laboratory reports.

CONCLUSIONS

Assessment has a profound effect on learning. It can motivate as well as act as a stimulus to bring students together to review their understandings. Good assessment and hence learning does not happen by accident, it is planned and should be guided by appropriate underpinning pedagogic principles. This peer assessment of laboratory report's, presented here, was steeped in such principles and appears to have been successful. The students indicated the learning benefits of the process (see table 3) and will hopefully translate the generalities from this exercise to other modules - this will be evaluated later. Irrespective of the longer term teaching and learning aspirations, immediate benefits arise with the opportunity to readily see what aspects of report writing or which features of the specific laboratory studies the students were struggling with. There was much evidence of students sharing what they were reading / assessing with their peers. Such learning opportunities - to share and distil good and bad practices from their peers work is not generally possible with a conventional, (*closed*), teacher-marked assessment.

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