

The Impact of a Constructivist Approach to Assessment and Feedback on Student Satisfaction and Learning: A case-study*

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Abstract

This paper adopts a case-study approach and applies assessment principles to two different cases, thereby illuminating some core features of assessment models that support learning in higher education. The cases are differentiated by the assessment instruments used: unseen examinations and coursework based on a two-stage written paper. The key interventions implemented were the use of criteria; exemplars, model answers and assessment workshops to communicate the criteria and standard; feedback to support learning; and, opportunities to apply the feedback in their final assignment. Data was collected over the period 2011 to 2015 via a questionnaire. An analysis of the quantitative data reveals that learners are highly satisfied with the assessment methodology. This finding applies to both cases, indicating that learner satisfaction ratings relate to the assessment process, rather than the selected assessment instruments. The qualitative data identifies feedback as a key feature of the assessment environment and reveals that learners identify with feedback that corrects, guides and motivates. A significance of the study is that it illustrates how both understanding and learner satisfaction can be enhanced by evidence-based assessment practices that focus on the assessment process.

Keywords: Formative assessment, feedback, constructivism, feedback-on-draft, two-stage assignment, understanding, case-study, questionnaire.

* URL: <http://ojs.aishe.org/index.php/aishe-j/article/view/287>

1. Introduction

For many practitioners in higher education, assessment is understood in terms of its *measurement* and grading role. Others see the primary role of assessment as promoting learning (William 2011). A central feature of this *assessment for learning* paradigm is feedback, and the ways in which learners engage with it and use it (Handley *et al.* 2008; O'Donovan *et al.* 2015). There is strong empirical evidence that, when done well, assessment for learning can have a large, positive impact on learning – larger than any other educational intervention (Hattie & Timperley 2007; Shute 2008). However, it is also acknowledged that assessment for learning is problematic to implement (Evans 2013). As a result, there is a wealth of evidence that indicates learner dissatisfaction with assessment (Radloff 2010; HEFCE 2014; ISSE 2016)

This paper adopts a case-study approach to illuminate some core features of assessment models that support learning. The case-studies allow for a rich description of the complex nature of the assessment process to be presented. Many academics lack a sophisticated understanding of assessment (Y1Feedback 2016) and this detail may provide a useful entry-point for academics that are seeking to improve their assessment practices. A contribution of the article is then that it illustrates how the same set of *assessment for learning* principles (Nicol & Macfarlane-Dick 2006; O'Donovan *et al.* 2015) can be applied to two different real-world cases. A second contribution is to evaluate the learner experience, and use this to illuminate key features of the assessment process that support deep approaches to learning.

2. Assessment FOR Learning

In this article, *assessment for learning* is understood to be “any assignment for which the first purpose in its design and practice is to serve the purpose of promoting students’ learning” (William 2011, p. 10). Our understanding of the relationship between assessment and learning has developed hugely over the last decade and figure 1 represents one conceptual map. The core literature used in generating this map is listed in the centre. The surrounding rectangles represent key concepts associated with *assessment for learning* e.g. characteristics, influential models, etc and summarise features associated with that concept. So, for example, a

characteristic of assessment for learning is that students act on the feedback they receive. The key in brackets after the feature is a reference to the literature e.g. (B701, E70) refers to the articles Boud & Molloy (2013), page 701 and Evans (2013), p. 70.

2.1 A Quality Feedback Product

When viewed as a product, quality feedback focuses addressing what is right/wrong, why it is right/wrong and, critically, how it can be improved (Shute 2008). Quality feedback should motivate learners by highlighting that which has been done well and managing the tone of the message to ensure that it encourages learners to persevere (Nicol and Macfarlene-Dick 2006). In addition, personal feedback is known to be more effective than generic or group statements (Handley *et al.* 2008). Generating quality feedback is not trivial – compromises exist between providing the detail and specificity that learners want (William 2011), generating a manageable product (Winstone *et al.* 2016) and developing independent learners (Carless *et al.* 2011).

While written feedback remains the most common form in higher education (Nicol 2010), recorded feedback offers some advantages. The existing research data indicates that, compared to written feedback, recorded feedback is detailed, richer, balanced, personal and developmental (Merry & Orsmond 2008, Chalmers & MacCallum 2014; Knauf 2016). However, student preferences are polarised (Chalmers & MacCallum 2014; Knauf 2016; Winstone *et al.* 2016) and a combination of methods may be more equitable (Knauf 2016; Winstone *et al.* 2016). At this juncture, there is relatively little research contrasting recorded audio feedback with recorded video feedback. Recorded audio is significantly faster to render (McCarthy 2015) and video benefits complex or visual assignments.

2.2 Feedback as a Social Constructivist Process

For the feedback product to be effective, learners need to act on the information to improve subsequent work (William 2011; O'Donovan *et al.* 2015). To this end, learners need to develop an appropriate understanding of the assessment criteria and standard. Providing learners with descriptions of the criteria and standard helps,

but creating opportunities to engage with these, by, for example, applying the criteria and standard to a range of exemplars (Handley et al. 2008; O'Donovan et al. 2015) is important. Through engagement and discussion, learners can construct an understanding of assessment requirements that parallels that of the tutor (Nicol & Macfarlane-Dick 2008; Nicol 2014) which positions learners to engage in self-appraisal and generate internal feedback (Nicol 2014).

Learner engagement with feedback is also linked to their perceptions of the utility of that feedback (Handley et al. 2008). In this context, two-stage assignments, that involve draft, feedback and rework, are frequently recommended (Handley et al. 2008; Carless et al. 2011; Boud & Molloy 2013; Winstone et al. 2016). As observed by O'Donovan et al. (2015), such assignments “clearly provides both motive to engage with feedback and opportunity to make use of it” (ibid., p. 6). A limitation is that the feedback may focus only on the immediate task and have little value beyond that task (Boud & Molloy 2013).

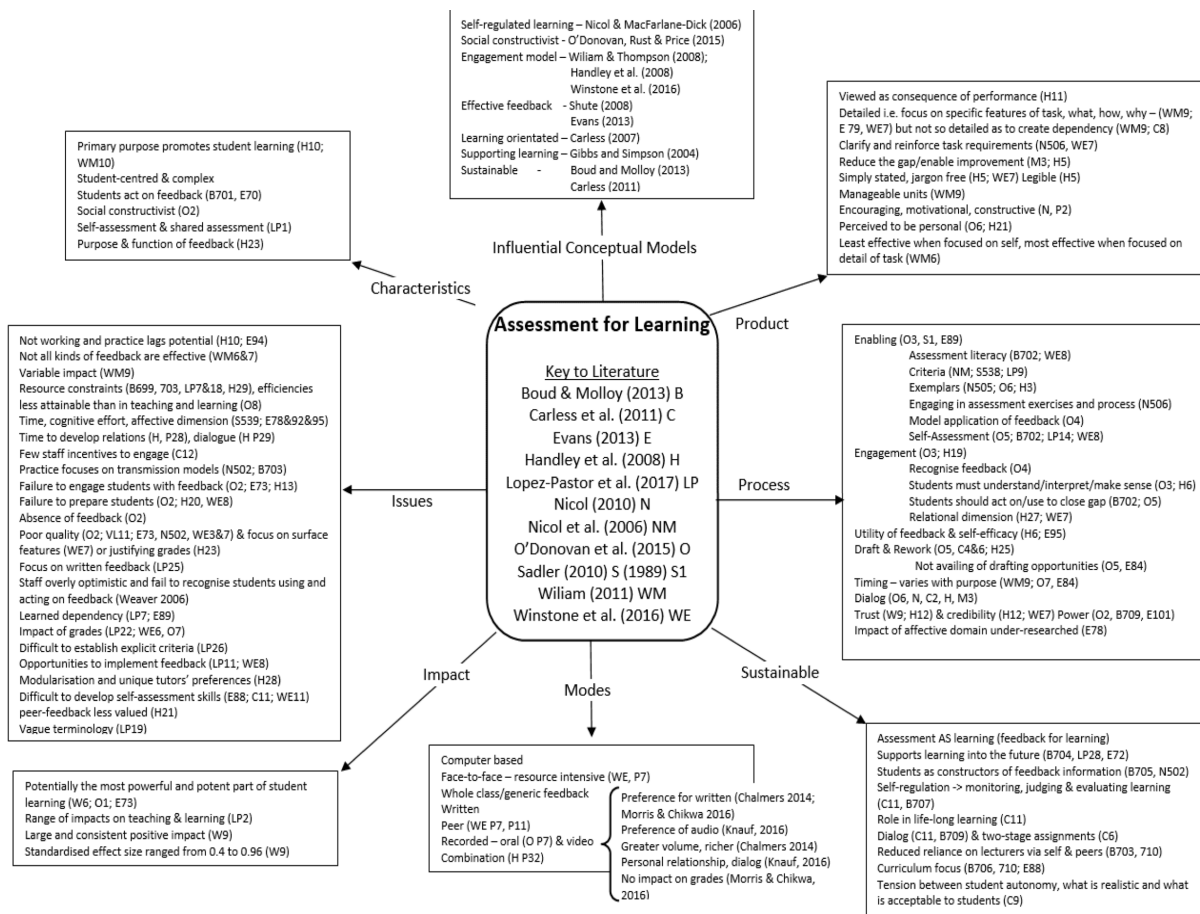


Figure 1: Conceptual Map of Assessment for Learning

2.3 Assessment for Learning in Practice

Reviews of assessment for learning have consistently established a large and positive impact on student learning (Wiliam 2011). However, the general consensus remains that practice significantly lags that potential (O'Donovan et al. 2015; Evans 2013). National surveys in, for example, the UK (HEFCE 2014) and Australia (Radloff 2010) highlight that students are less satisfied with assessment than any other feature of their courses. The data that exists in relation to the Irish experience is not encouraging. For example, in response to how frequently they discussed performance with academic staff, in 2016 46% of Irish first-year students in third-level education claim they *never* had such discussions (comparable data from the UK is 17%; the US 24%) (ISSE 2016).

2.4 Why does assessment practice not live up to its potential?

The literature also provides some insights as to why this gap might exist. The absence of a nuanced understanding of assessment and feedback coupled with the cognitive effort required to develop this understanding along with few incentives to engage in feedback practices (Carless et al. 2011) may account for the absence of feedback (ISSE 2016) and its variable impact (Wiliam 2011). The resources required to create a quality feedback product, to develop a supportive relationship and facilitate dialogue around assessment (Handley et al. 2008) in the current, modularised environment where the burden on academic staff is increasing (Boud & Molloy 2013; López-Pastor & Sicilia-Camacho 2017) places real limitations on what is feasible. As a result, a poor quality feedback product is often transmitted (Nicol and Macfarlane-Dick 2006). Learners are then unprepared or unable to deal with this feedback (O'Donovan et al. 2015; Evans 2013). Of relevance to this article is the complex nature of assessment, the burden on academic staff and their, often, limited understanding of the role of the feedback process. As outlined in the next sections, by presenting this research as a case-study, the author hopes to serve busy academics by providing concrete examples of principles in practice.

3. Research Method

An aim of this specific piece of research is to explore learner perceptions of the assessment process employed by the author. It follows, that a predominantly qualitative research methodology, rooted in the interpretivist epistemology, would support this aim. The primary advantage of this interpretivist approach is that it supports the development of a multi-layered, complex and authentic description (Cohen et al. 2011). However, the subjective nature of this research also raises concerns relating to the reliability, validity and generalisability of the findings. In this study, findings drawn from quantitative data were compared those that emerged from a thematic analysis of open-ended questions. Convergence lends a certain confidence to the findings and adds to the validity and reliability of the research (Cohen et al. 2011). Furthermore, as the number of registered students on some of these modules is low (13 students), a longitudinal approach (2011 – 2015) was used to increase the quantity of data, and hence the validity of the study. In the purest sense, generalisability is not possible. However, by embedding the research in the assessment literature, and by focusing on general principles from that literature, both the interventions and results should be transferrable to similar contexts.

This article also aims to address some of the issues that were identified with assessment as it is currently practiced in higher education. For example, in the Y1Feedback study, while 83% of academic respondents strongly agreed that “feedback is an integral part of student learning” only 25% strongly agreed that “preparing students for receiving feedback is important” (Y1Feedback, 2016). Hence, by presenting this as a case-study it is hoped that the article may serve practitioners (Nicol & Draper 2009). Case-studies can develop understanding because they are born from practice and use concrete examples. Multiple cases extend this by illustrating how the same idea can be realised in different ways and may reveal additional insights. However, case studies are known to be prone to observer bias and due care and diligence must be exercised by the researcher to address this (Cohen et al. 2011).

4. Assessment Instruments and Process

4.1 Assessment Instruments

Up until 2015, the author taught four undergraduate modules each academic year. Each is a mandatory module on an engineering programme, worth five ECTS credits. The overarching design consideration was that the assessment process would work in tandem with other aspects of the module to encourage a deep approach to learning (Entwistle 2010). For three of the modules, the aim is to develop competence in a specific type of engineering design – controller design. To realise this aim, these modules employ a constructivist teaching philosophy centered on project-based learning (Mills & Treagust 2016). A written paper was selected as the primary assessment instrument as it allows for the learners' authentic experience to be described. For the purposes of this study, these three modules are grouped into one case – based on the similarity of the module aims, teaching and assessment methodology. Key features are summarised in Table 1[1]. Note that for two of these modules, teamwork forms a component of the learning experience and therefore instruments to assess this (a team website) feature in these modules.

The remaining module is an introductory module whose aim is to develop an understanding of the key concepts associated with the discipline. The assessment strategy consists of laboratory reports and written exams. These are appropriate, given the focus of the module. This single module represents case 2, and is summarised in Table 2. Note that in any particular year, assignment due dates are agreed in consultation.

[1] Complete module descriptors can be found at <http://courses.cit.ie/index.cfm> by searching via the module titles in Table 1

Table 1 and Table 2 are indicative. These four modules then represent two distinctly different cases with Case 1 being somewhat innovative and less usual and Case 2 typifying the assessment process used in engineering.

Module Title	Control Engineering	Embedded Control Systems	Digital Controller Design
Context	Year 4, Semester 2 of the BEng. (Hons) in Electronic Eng.	Year 4, Semester 1 of the BEng. (Hons) in Electronic Eng.	Year 4, Semester 2 of the BEng. (Hons) in Electrical Eng.
Teaching Method	2 hour lecture per week. 2 hour laboratory organised as a team-based semester-long project.	2 hour lecture per week. 2 hour laboratory organised as a team-based semester-long project.	2 hour lecture per week. 2 hour laboratory organised as an individual semester-long project.
Assessment Components	Paper: Prepare an individual engineering style conference paper (80%). Paper should present an understanding of the design process and outcomes. Website: Maintain a team website to manage project and organise the team, document team meetings, record individual responsibilities (20%).	Paper: Prepare an individual engineering style conference paper (70%). Paper should present an understanding of the design process and outcomes. Website: Maintain a team website to manage project and organise the team, document team meetings, record individual responsibilities (30%).	Paper: Prepare an individual engineering style conference paper (100%). Should present an understanding of the design process and outcomes.
Indicative Assessment Time-line	Week 4: Submit short (2 pages) draft of paper. Receive feedback. Week 6: Formative assessment on websites Week 9: Submit draft of final paper. Receive feedback. Week 14: Paper and websites finalised	Week 4: Submit short (2 pages) draft of paper. Receive feedback. Week 6: Formative assessment on websites Week 9: Submit draft of final paper. Receive feedback. Week 14: Paper and websites finalised	Week 4: Submit short (2 pages) draft of paper. Receive feedback. Week 9: Submit draft of final paper. Receive feedback. Week 14: Paper finalised

Table 1. Summary Description of the Modules that form Case 1

Module Title	Control Systems
Context	Year 3, Semester 2 of the BEng. in Electrical Eng.
Teaching Methodology	2 hour lecture per week. 2 hour laboratory organised as individual laboratories.
Assessment Components	3 x laboratory reports that integrate findings from a number of laboratories (30%). Mid-semester closed-book written assessment (20%). End-of-semester closed-book written examination (50%).
Indicative Assessment	Week 5: Submit first laboratory report. Receive feedback. Week 7: Mid-semester examination. Receive feedback.

Table 2. Summary Description of the Module that forms Case 2.

4.2 Assessment Process

The assessment process was strongly influenced by the social-constructivist assessment model advanced by O'Donovan et al. (2015) and the principles of good assessment and feedback advocated by Nicol and Macfarlane-Dick (2006). These were applied to both cases, albeit in slightly different ways given the different contexts. The main interventions were the use of assessment criteria and standards, exemplars, written and audio-recorded feedback^[1], in-class assessment workshops and whole-class feedback sessions. It is useful to map these interventions against the taxonomy developed by Winstone et al. (2016) to better understand the engagement processes that the interventions targeted. Table 3 presents this mapping and it is evident that, in both cases, the interventions were mostly targeted at improving *assessment literacy* and *engaging and motivating* learners.

Assessment literacy is important in order to *enable* learners engage with assessment and feedback but not always valued by staff (Y1Feedback 2016). In keeping with Handley et al. (2008), marking schemes were used in both cases as informal feedback indicated that learners found assessment grids difficult to interpret. Appendices 1 and 2 present examples marking schemes. For Case 1, the assessment standard was then articulated by providing exemplars from past assignments and organising in-class assessment workshops where learners worked in small groups to discuss interpretations and apply the marking schemes to the exemplars. Given the number of assessment components associated with Case 2, time did not permit for an equivalent in-class assessment workshop for each component. Instead, for each component, the marking scheme and expectation was explained. Exemplars were not provided for the laboratory reports, but past examination papers and model answers were available for both examinations.

For Case 1, the two-stage assessment process was central to promoting engagement and motivation. Given that the assessment criteria does not change, the two-stage assessment provides clear motive and opportunity to engage because all of the feedback can be directly applied to the final submission. In contrast, for Case 2, some of the feedback on early assessments is bound to the context of those assessments and the opportunities to apply the feedback may be fewer and less obvious. In all cases, brief written feedback was provided on the marking scheme. The final assignment for Case 1 is significant (worth >70% of the module) and tends to be quite individual. Therefore, audio feedback was provided on the draft of this assignment as it allows for detailed, developmental and individual feedback to be generated – over a faster time-frame than an equivalent volume of written feedback could be. In contrast, the individual coursework components for Case 2 are less significant, they tend to be less individual and therefore a pro-forma written feedback template can be quite effective. Appendix 3 presents an example that includes the criteria, model answer excerpt, evaluative comment and grade. When appropriate, whole class feedback was a feature of both cases and would have focused on common errors or misconceptions that were identified.

[1] This study elected to use recorded audio feedback because it is faster to render than video feedback (McCarthy 2015) and because the assignment was text-based which is relatively easy to signpost. It is most likely that recorded video feedback would have yielded the same types of results as are presented later on in this paper.

SAGE Taxonomy	Case 1 (Table 1)	Case 2 (Table 2)
Self-appraisal	Marking scheme for written paper	Marking scheme for laboratory reports and past exams
Assessment literacy	Marking scheme to articulate criteria Exemplars to articulate standard Learner-centered, in-class assessment workshops to apply criteria to exemplar and discuss interpretations	Marking scheme to articulate criteria Past exam papers Model answers for past exam papers Lecturer discussed and explained the marking scheme and expectation
Goal setting and self-regulation	In-class assessment workshops to apply criteria to exemplar and discuss interpretations Individual recorded audio feedback	Not explicitly targeted
Engagement and motivation	Two-stage assessment process Individual written feedback on marking scheme Individual recorded audio feedback Whole class feedback on generic issues	Final exam and lab reports no 2 & 3 Solutions/model answers for lab reports and exams provided <i>post hoc</i> Individual written feedback on laboratory reports and examination scripts Whole class feedback on first examination

Table 3: Summary of interventions mapped against the SAGE taxonomy (Winstone *et al.*, 2016)

5. Data Collection and Analysis

An on-line questionnaire was used to examine learner's perceptions of these modules. Between 2011 and 2015 the questionnaire included a common section on assessment. The questions related to assessment were mainly drawn from the UK National Students Survey (UK-NSS) (HEFCE 2014) and the US National Survey of Student Engagement (NSSE 2016). The rationale for choosing these questions is that they had been through a rigorous design process and would allow data to be benchmarked. Table 4 presents the relevant questions; with Q1 – Q8 being Likert-scale questions and Q9 – Q10 being open-ended questions. The responses to

closed questions were analysed by determining satisfaction ratings i.e. the % that agreed with the question.

Q	Question Stem in Student Questionnaire
1	The criteria used in marking the assignments were made in clear in advance
2	The assessment arrangements and marking used in this module were fair
3	I received prompt feedback on the work that I submitted in this module
4	I received detailed comments on my work during this module
5	The feedback that I received on my work helped me to clarify things that I did not understand
6	To what extent did the assessment tasks in this module challenge you to do your best work?
7	In this module did you have to work harder than you expected to meet the expectations or standards of the lecturer?
8	In your opinion, the workload associated with this module was: [Too low, about right, too high, much too high]
9	Looking back on the module are there any particularly praiseworthy aspects? [open-ended question]
10	Looking back on the module are there any aspects that could be improved? [open-ended question]

Table 4: Assessment Component of the Student Feedback Questionnaire

An inductive approach was used to identify themes from responses to Q9 and Q10 by following the steps suggested by Brenner et al. (1985), as cited by Cohen et al. (2011). There are numerous ways to approach the actual coding of textual data (Ryan & Bernard 2003; Cohen et al. 2011). In this research, the constant comparison method was primarily used and the outcome validated using frequency word lists. Initially, the data was open-coded by underling key phrases that represented discrete concepts. Subsequently, a line-by-line analysis was undertaken to examine how the identified codes related to, or were distinct from each other. These codes were grouped into themes and then enumerated to identify the dominant ones.

6. Results & Discussion on Quantitative Data

Table 5 displays a summary of the quantitative data. So for example, in relation to Case 1, the 83% corresponds to an average of 83% of the respondents selecting *agree* or *strongly agree* in response to Q1. This average was determined by aggregating data from the three modules that comprise Case 1 (Table 1) over the period 2011 to 2015. The average was derived from six^[1] individual questionnaires, totalling 62 respondents (N) and the average response rate was 52%. From Table 5 it is very clear that learners are satisfied with the criteria, grading and both the timing and quality of the feedback associated with **both** Cases (Q1 – Q5). It is also clear that they find both assessment processes a challenge (Q6), that they had to work harder than anticipated (Q7) but that the workload is “about right” (Q8), which is important if deep approaches to learning are desired (Entwistle 2010).

The findings from Case 2 show that *standard assessment instruments* can achieve high ratings. The similarity of the results arising from both cases indicates that satisfaction ratings are not dictated by the assessment instrument. The significance then, is that these findings point to the need to re-focus assessment in Higher Education on the *assessment process*, rather than *assessment instruments*. Because Q1 to Q5 were taken from the UK-NSS, results can be benchmarked against this data (HEFCE 2014). Obviously, this benchmarking is not comparing like-with-like as the UK-NSS is programme based and the data presented here is derived from individual modules. However, the benchmarking does illustrate that learner satisfaction with assessment can be improved by using the evidence-based literature to develop an appropriate assessment process. Significantly, the data suggests that if an evidence-based assessment process was replicated throughout a programme, assessment and feedback could move from the lowest rated scale on the UK-NSS instrument to the highest rated scale.

	N	Response Rate	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Case 1	62	52%	83%	90%	92%	92%	90%	98%	80%	85%
Case 2	61	42%	95%	95%	88%	92%	93%	97%	90%	87%
UK NSS	~320,000	~70%	76%	76%	69%	71%	66%	-	-	-

Table 5: Summary of Quantitative Results. (N is the no. of respondents. Q1 – Q8 are detailed in Table 4. NSS ratings are for full-time taught HE programmes in England)

7. Results & Discussion on Qualitative Data

The analysis of the open-ended responses identified *assessment and feedback* as a recurring theme. Data related to this theme was aggregated. The responses to Q9 (Table 4) relating to praiseworthy aspects then amounted to 862 words while those relating to Q10 consisted of 866 words. The data analysis approach (Section 3) was re-applied to this segregated data and the emergent themes focused on feedback, assessment criteria, the two-stage assignment and the assessment standard.

7.1 Feedback enhances understanding

The dominant theme (69% of individual comments) related to feedback. Important attributes are summarised in Table 6. A high percentage of the comments were generic e.g. “feedback on reports was extremely helpful” but did not elaborate. This is documented in column 2 (helpful) and column 3 (good) of Table 6. Specific comments from learners identified the corrective function of feedback and the impact

[1] Note that not all modules were surveyed every year

that had on learning. For example, learners noted that the feedback “was a great help in understanding where faults were made” and enabled learners to “learn from mistakes”. Learners commented on how the feedback guided them by providing “very clear points on what to change or work on in order to improve”. Learners noted that the feedback was “good in its praises for the student for what was done correctly” and “was great to motivate towards the final report”. Resonating with the quantitative data (Q4), learners commented positively on the “detailed feedback”. Learners stated that the feedback “from the reports not only helped me see where I went wrong but helped improve my understanding”. In summary then, the corrective, guiding, detailed and motivating nature of the feedback contributed to a better understanding of the module content. These attributes are entirely consistent with existing views of *feedback as a product*, as summarised in Figure 1, and therefore strongly supported by the literature.

Feedback Attributes	Helpful	Good	Correcting	Guiding	Detailed	Motivating	Understanding	Feed-forward
No. of individual comments	11	10	6	3	3	3	4	2

Table 6: Attributes of feedback identified from responses to open-ended questions.

7.2 The Yen and Yang with Assessment Criteria

There was also significant commentary (13 comments) on the assessment criteria. This commentary was mixed (5 positive and 8 negative). On the positive side, learners noted that the assessment criteria was good and that the “marking scheme is very helpful for understanding the expectations from the coursework”. Four of the negative comments related to specific issues that would have been addressed in the following year. More generally, many learners felt that the criteria were a “bit up for interpretation” and that they “found it hard to reconcile the marking scheme to the work, in so far as I thought I had hit the points but in reality didn't”. This finding is not uncommon. For example, in their review López-Pastor & Sicilia-Camacho (2017) highlight the challenge associated with translating assessment criteria and standards from a predominantly tacit tutor understanding into an explicit, shared understanding while the work of Nicol (2014) also focuses on this issue.

7.3 Reports & Two Stage Assessment Model Develops Understanding

The two-stage assessment model was a third significant theme (13 comments) that emerged from the data. The majority of the comments (62%) were positive with learners noting that the “reports allows you to learn in a practical way without having to memorise things for an exam”. They felt that the “allowance of drafts to be submitted was highly beneficial” as when combined “with great feedback [they] allowed students to achieve a better understanding” and “to maximise their results”. The data also revealed that some learners “find it hard to get my point across in my reports mainly because I am afraid I would say the wrong thing”. Others held the

opinion “that the student is being marked more on their English on paper rather than what they know”. There is a sense that some learners would prefer to be graded based on what they did rather than what they understood, hence, although there is strong support for the two-stage assessment model, there is scope for further supports to be developed.

7.4 Scaffolding the Assessment Challenge

The final theme that emerged from the data related to the challenge associated with reaching the standard (11 comments). Learners commented that the “assignments were tough” and “the final paper required more study time than I had available”. However, the quantitative data (table 5) reveals that while learners were challenged, the workload was “about right”. Others noted how “without the feedback through the audio, the module would have been much more difficult” suggesting that the scaffolds used to support the challenge were effective for many. As a result, many felt that the “module was fair in assessing students” because “you get the results if you put in the effort” which, again, is consistent with the quantitative data (Q2).

8. Conclusion

Over the past two decades, assessment research has focused on developing our understanding of *Assessment for Learning* (see figure 1). That literature is now quite mature. However, in the majority, academic practice remains bound to the original conception of assessment – grading. The potential impact of assessment on learning remains untapped. The literature also provides some insights into why this might be the case: staff workload, few incentives and the complexity of the assessment process makes it difficult to develop a nuanced understanding. This work aims to be of value by illustrating how a set of principles were applied to two different real-world cases. The research literature and empirical data were then used to identify and highlight key features of these implementations (Table 3, Table 6, Section 7). Furthermore, the empirical data was used to demonstrate that high levels of learner satisfaction (Table 5) can be achieved if the *assessment process* is grounded in evidence-based approaches.

The model is not without its challenges. The balance between providing specific, detailed and developmental feedback and creating dependent learners is an on-going point for reflection. Developing a shared understanding of both the criteria and standard is a critical component of self-regulation and the migration towards *assessment AS learning* (Carless et al. 2011; Boud & Molloy 2013). However, it is evident from this work that many learners struggled to develop a sufficient understanding, and this issue needs further exploration for the migration towards *assessment AS learning* to be successful.

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Appendix 1: Excerpt from a Marking Scheme with Brief Evaluative Comments and Grade

ELX4 Embedded Control. Marking Scheme for Design Paper

Student name R00094389 _____ Draft _____ Final _____
 Result __55%__ Result __63%__

	Description of assessment criteria	Level of performance achieved
7.5/10 LO2: Modelling	The decision to use a first-order transfer function is justified based on data obtained	Yes
	Clearly and accurately defined parameters of a first-order transfer function	yes
	Clearly explained how parameters of the first-order transfer function were calculated	OK
	Validated transfer function using open-loop data. Process is explained and accuracy commented on.	yes
	Validated transfer function using closed-loop data. Process is explained and accuracy commented on.	OK
	Explained why closed-loop validation is necessary	OK

Appendix 2 Excerpt from Marking Scheme used with lab reports than includes criteria and expected standard

Marking Scheme for Laboratory Report No. 3

Student Name:

Mark (%)

Criteria	Standard Expected	Max No Points
Introduction	Should be short, summarise objectives and the simulation system that was used	5
Explanation of closed-loop integral control	Figure with results e.g corresponding to step 4 of Lab 8. Clearly explain how integral control works. Your explanation should use the calculation that was performed in step 4. Your explanation should clearly reference the error signal and explain how the control signal is generated from that error signal.	10
Explanation of proportional plus integral control	Figure with proportional plus integral results e.g. corresponding to step 4 of Lab9. Clearly explain how proportional plus integral control works. Your explanation should include a discussion on how the proportional part is obtained from the error signal and how the integral part is obtained from the error signal.	10

Appendix 3 Excerpt from Feedback Template used with lab reports than includes criteria, model answer, brief evaluative comments and grade

Feedback for Laboratory Report No. 3

Student Name: [REDACTED]

Criteria	Comment	Points
<p>Introduction: model answer A good introduction should explain what the main objectives were and explain how they were investigated. The main objectives were to (i) explain integral control, (ii) explain proportional plus integral control, (iii) discuss advantages and limitations of proportional and integral control, (iv) explain how to design a PI controller (v) and evaluate the performance of the different controllers designed to select the most appropriate design. These were investigated through the simulation of a building temperature control system. Should explain that the room temperature is being controlled, that the air-temperature and number of people in the room act as disturbances.</p>	<p>Objectives (4) OK</p> <p>Simulation (1) no</p>	3 out of 5
<p>Explanation of closed-loop integral control. Key sentence here is that integral control works by determining the area associated with the error signal. By calculating the initial area of the error signal and relating that to the integral signal at that time you show that you understand that idea. If we consider Fig 1 at t = 20hrs, then the area associated with the error signal is $20 \times 3600 \times 8 \times 0.5 \times 0.00001 = 2.88$ ($k_i = 0.00001$). This is approximately equal to the integrator output at this time. If appropriate you should explain the remainder of the integral signal. Again looking at Fig 1, between t=20hrs and t=45hrs the error is negative. That means the area associated with that is negative. Therefore the total integral will be the initial positive area (2.88) minus this negative area which will reduce the amplitude</p>	<p>Idea that the integrator is a function of the area of the error yes Area calculated yes Area clearly related to the integral output at that time no remainder of the integral</p>	8 out of 10

Model Answer

Assessment Criteria

Evaluative comments

Grade

