

## **Perceptions of feedback in mathematics – results from a preliminary investigation at three Australian universities**

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Feedback on learning is recognised as so important that it features on student evaluation of teaching surveys and on Australia's national Course Experience Questionnaire. Ideally, the student responses are then used to improve on practices. However, we argue that this process is flawed in first year mathematics. In this pilot study, we surveyed students enrolled in first year mathematics subjects at three Australian universities about their perceptions of feedback. Students were asked what they considered to be feedback in mathematics and what feedback they had received in their mathematics subject. In this study we compare these answers to the lecturers' views of what types of feedback were provided. We come to the conclusion that students enrolled in first year mathematics subjects perceive feedback very differently to their lecturers. This devalues the usefulness of questions about feedback on end-of-semester surveys on the quality of teaching. We also question whether students may be missing out on accessing feedback that is intentionally provided to improve their learning.

### **Introduction**

The place of feedback in a student's learning is pivotal. Used well, it helps students to improve their work, feel supported and secure as they grapple with new concepts and material. Feedback contributes to them achieving their potential. Understandably, feedback is an item students comment on both in the Australian Course<sup>1</sup> Experience Questionnaire (CEQ) and in the university student evaluations of teaching. The feedback we give as instructors is often modelled on the type of feedback we received as students and what we perceived as useful. Are these tried and true feedback attempts still relevant and effective to the current generation of students?

The term "feedback" implies that a message is given and that a message is received. The message could be verbal or written, specific or general, but in all cases needs to be received to be of any value. Our study of feedback came about through discussions between the authors at the last Delta conference, who all exhibited various degrees of frustration at a mismatch between the types of feedback they thought they were providing to their students, and the views that their students gave on the types of feedback they had received. It seemed that this was a widespread frustration, at least for mathematicians. We therefore ask the following questions:

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<sup>1</sup> Here "course" means "degree".

- What do students consider to be feedback in mathematics?
- What feedback have students received in their mathematics subject<sup>2</sup>?

To find answers to these questions, we ran a survey across three Australian universities: A research intensive university, a metropolitan technical university (both located in Melbourne), and a multi-campus university that provides higher education to the greater Western Sydney region. The survey was held in class in first year mathematics subjects. Students were not guided or prompted to answer the questions in a particular direction. The two questions asked that were relevant to the research questions above were: “What do you consider to be feedback?” and “What, if any, feedback have you received so far in [subject name]?”

In this paper, we discuss the students’ responses in the context of the feedback the lecturers have provided in the subjects. This study forms a preliminary stage of our research into feedback in mathematics. Experiences from this pilot study will be used to redesign the questionnaire.

This paper is organised as follows. We first provide an overview of the literature on feedback, and in particular on feedback in mathematics learning. We then provide the contexts of the three mathematics subjects that have been surveyed, and detail the methods used in this study. We analyse and discuss the student responses to the survey in light of what feedback the lecturers said was available, to provide answers to the questions we have raised. We conclude with suggestions for future directions.

## **Literature review**

We will give a brief review of the general role and importance of feedback in higher education before we focus on feedback in tertiary mathematics education.

### ***Feedback in tertiary education***

Sadler [1] sees feedback as a key element in formative assessment, and lists three necessary conditions for effective feedback: understanding the required level of performance, comparing your own performance to this required level, and engaging in action to lead to a reduction of this gap. Gibbs and Simpson [2] provide ten “conditions under which assessment supports learning”, seven of which relate to feedback [3], with emphasis on timing, content/quality, and student engagement. This highlights the importance of feedback as part of the assessment process.

Walker [4, p.68] writes that feedback could be information about the gap between performance and a reference level, or it could be information about a gap that can be used by the student to alter that gap. However, information that there is a gap could be considered to be a form of feedback. Something as simple as “good work” which one would usually take to mean that the required standard has been reached could also be considered as feedback. Walker [4, p.69] notes that comments which praise students’ work might be appreciated and so be important, yet Hattie and Timperley [5, p.96] claim that praise is ineffective. They see feedback as “information provided by an agent (e.g., teacher, peer, book, parent, self, experience) regarding aspects of one’s performance or understanding.” [5, p.81].

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<sup>2</sup> For simplicity, in this paper we will refer to individual units, courses, subjects, such as “Mathematics 1”, as **subjects**. We will refer to programs, courses, degrees, such as “Bachelor of Engineering”, as **degrees**.

Walker [4, p.73] found that 67% of comments on assignments were useful to students for subsequent assignments. When asked what students wanted,

Two themes emerged strongly. One was that they wished to be told what they had got wrong, and why, and how to do better. ... The other was that they would appreciate being given things to work on or watch out for in future assignments, or just receiving general suggestions for their future assignments.

Weaver [6, p.379] writes “Focus has been primarily on content analysis of feedback, and providing advice on writing effective feedback”. This is not where our research lies; it lies in a less researched area, student perceptions, as Weaver continues: “the topic of feedback to students is an under-researched area, and there has been little empirical research published which focuses on student perceptions.” [6, p.379]. Restricting to technical subjects, such as mathematics, where the assessments are not essays, one finds very little research. Some universities ask about feedback in student evaluation of teaching surveys, however, if staff do not understand what students perceive to be feedback then such survey questions are of little use.

Students’ perceptions of the feedback they receive are important. James et al. [7], on the first year experience, write “Feedback continues to be an issue. One-third of students do not believe they receive helpful feedback on their progress. Only 26 per cent of first year students believe staff take an interest in their progress.” Ramsden [8, p.107] comments that on the CEQ, the statement “Teaching staff here normally give helpful feedback on how you are going” finds student agreement on the “good courses<sup>3</sup>”, and disagreement on the “bad courses<sup>3</sup>”. He claims that “this item most clearly differentiated the best and worst courses<sup>3</sup>”.

In response to the statements from Ramsden above, Gibbs and Simpson [2, p.10] comment that “it means that whether or not they give helpful feedback makes more difference than anything else they do.” Hence those responsible for first year teaching should care about students’ perceptions of feedback. For those who focus primarily on the CEQ results, and in many places the student experience is considered to be of prime importance, feedback could therefore be less about a gap in knowledge and more about student happiness. The issue of feedback is not straightforward.

### ***Feedback in tertiary mathematics education***

The following quote from a UK study on effective feedback in mathematics [3] shows the length to which some staff will go to improve their feedback scores:

We don’t mark work anymore; we give feedback. We don’t talk to students; we give feedback. We don’t give out model solutions; we give them feedback sheets. I don’t have office hours; I have feedback hours. Basically it’s a big rebranding exercise.

Such a “rebranding exercise” may improve awareness among students of what the university wants them to think feedback is. It does not, however, improve the quality of feedback provided or the effectiveness of that feedback.

On the other hand, James et al. [7] find that “overall, the mature-age students aged 25 years and over emerge as a highly satisfied group. They express strong satisfaction with their courses and strongly believe they are receiving helpful feedback from their teachers.” We

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<sup>3</sup> We interpret these as *subjects*

argue that this is in contrast to first year mathematics subjects where the majority of students transitioned straight from secondary school. It appears that first year students may not have the maturity to use feedback to benefit their learning, to identify where they should be, where they are, and how to get to where they should be (rephrasing Sadler [1]). These students have not yet developed skills (and some may never do so) to self-regulate their own performance, they don't actively engage in processing learning resources such as feedback [9], and may therefore not become effective learners.

Robinson's study [3] is motivated by similar reasons to ours, that is, that students in the UK also score questions relating to feedback poorly on the National Student Survey. To identify what actually constitutes effective feedback in mathematics, Robinson compares current typical practices from a number of UK mathematics departments, including innovations in the type and provision of feedback. He finds that there are two aspects that much mathematical feedback focuses on, namely "providing exemplars, typically in the form of model solutions, and identifying student errors". At the same time, he acknowledges that students may also need different types of feedback, and in particular feedback that prompts them to take action. In fact, Robinson establishes that "effective feedback needs to be timely, good quality, and crucially [...] it should provoke some action from students to promote further learning." Robinson asked questions such as what students considered as "feedback", to what extent they used the feedback, or found it helpful, and what students actually do with the feedback they receive. For the interested reader, Robinson combines examples of the role of feedback from Gibbs and Simpson [2] with the principles of good feedback practice by Nicol and Macfarlane-Dick [9] to a list of ten possible goals of feedback [3].

The purpose of this paper is to compare student and staff views of feedback provided in three mathematics subjects. The intention is not to determine whether feedback in the subjects under consideration is effective in improving learning. Indeed, the issue of feedback can be very complicated and problematic; for example, Lizzio and Wilson [10, p.263] state that "in over one-third of cases feedback interventions were found to actually decrease performance."

## **Contexts and methods**

We first outline the contexts of the three subjects surveyed in this study, and then detail the methods used. At each of the three participating institutions, the particular lecture stream of the subject that was surveyed was lectured by one of the authors. For each, we present the type of subject that was surveyed including student background and size of enrolment.

### ***The University of Melbourne***

At the University of Melbourne (UM), the survey was conducted in Calculus 1. The students in this subject are primarily first year students in their first semester of university study. The prerequisite for entry to the subject is the subject Maths Methods 3/4 (a calculus based intermediate level course taken in the final year of secondary school). The enrolment in the subject was 777, with 509 students from the Faculty of Science (including engineering pathways), 128 students from the Faculty of Environments (also including some engineering pathways), 104 students from the Faculty of Commerce, with the remaining 36 students from the Faculties of Arts, Music and Biomedicine. The lecture stream surveyed had approximately 300 students enrolled.

### ***Swinburne University of Technology***

At Swinburne University of Technology (SUT) the survey was conducted in Engineering Mathematics 1. As with the UM subject Calculus 1, the students enrolled in this subject were primarily first year students in their first semester of study. The prerequisite for the subject is also Maths Methods 3/4. The enrolment was approximately 500 students. The majority of students enrolled were engineering students with some science and IT students. There were approximately 70 students enrolled in the lecture stream that was surveyed.

### ***University of Western Sydney***

At the University of Western Sydney (UWS) students in the subject Fundamentals of Mathematics were surveyed. The enrolment of the subject was 117 and there was only one lecture stream. The subject is a basic first year, service mathematics subject. The vast majority of students are studying industrial design (90%); for these students the subject is compulsory. Students in this subject might not have completed any mathematics subjects in their final year of secondary school.

### ***Methods***

The survey was first offered at UWS. Following analysis of the responses in which it was found that few students gave meaningful answers to more specific questions on feedback, these questions were removed and the shortened survey was then run at UM and SUT. The paper-based surveys consisted of open ended questions and were handed out in lectures in the three first year mathematics subjects listed above: Calculus 1, Engineering Mathematics 1, and Fundamentals of Mathematics. We received 58 responses from the 300 UM students, 39 from the 70 SUT students, and 53 responses from the 117 UWS students.

A thematic analysis of the data was undertaken with at least two of the authors reading all answers to the two questions from each university. This analysis focused on answering the research questions:

- What do students consider to be feedback in mathematics?
- What feedback have students received in their mathematics subject?

We interpret the second question in two ways: What students think they have received, and what lecturers have provided. We used qualitative research methods to investigate students' perceptions of feedback. In the results below, we take a three step approach to answer the two research questions.

### ***Results***

We first list the types of feedback we as teaching staff thought we had provided to students at the three universities. In step two, we show and discuss the themes we extracted from the student answers to the open-ended questions: "What do you consider to be feedback", and "what, if any, feedback have you received so far in [*subject name*]". At least two of the authors read the responses from each university. All three authors discussed possible themes, searching for commonality across universities. The themes for SUT are necessarily different to those for UM and UWS, since the assignments in the SUT subject were marked electronically without individual marker feedback. There is some overlap in the themes, for example, "assessments marked" and "ways to improve"; this is a result of the open ended questions. Note that some themes extracted at individual universities are described in the text rather than being visualised in diagrams. In step three, we compare the two perspectives and discuss the results from the lecturer perspective. We report on this separately for the three universities.

## ***The University of Melbourne***

### ***4.1.1 Lecturer view of feedback provided***

During the semester a variety of feedback processes were employed:

- Ten weekly assignments were marked and returned to students with minimal comments given on each. Fully worked solutions were made available.
- During weekly tutorials students worked in groups interacting with each other and with tutors. Fully worked solutions for all tutorial questions were given to students at the end of each class.
- The lectures were interactive, providing opportunities for students to engage with the material and do a variety of problems themselves during each lecture. The lecturer walked around the lecture theatre fielding questions.
- Students had the opportunity to question the lecturer for five minutes or so at the end of most lectures.
- Three hours of consultation per week with the lecturer available to students with many additional consultation hours provided by tutors.

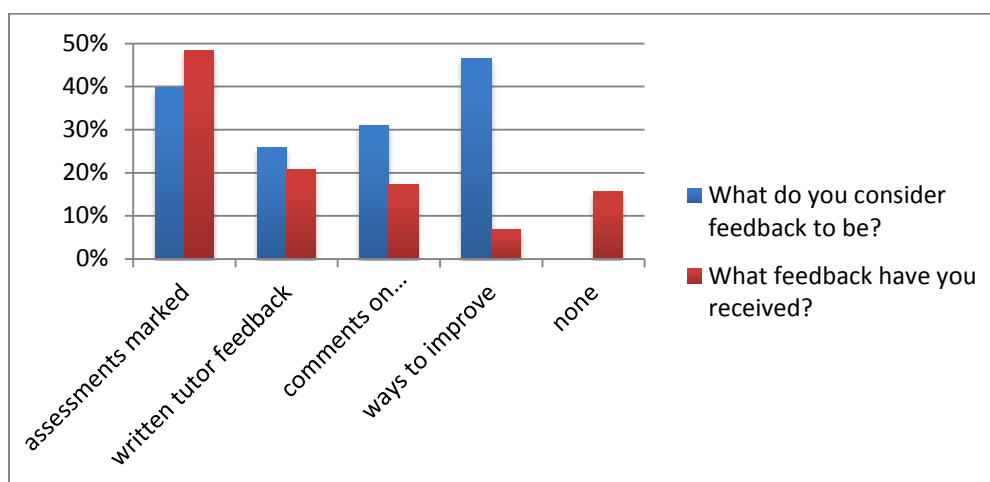
Note that the student evaluations of teaching included the question “I received valuable feedback on my progress”. For this subject, the score on this question was 4 out of 5, where 3 means neutral, 4 agree, and 5 strongly agree. This was significantly higher than the average on this question across the faculty.

### ***4.1.2 Student view of what feedback is, and what feedback they received***

Figure 1 illustrates the themes that emerged from the data, and the number of students who were coded with this response. Fewer than half the students (40%) considered that assignments marked constituted feedback, whilst around 26% considered written comments on assignments as feedback. A larger group of students (31%) claimed that comments on their progress or comments in tutorials is feedback, with 46% of students explicitly commenting that feedback is about ways to improve or constructive criticism.

Many students explicitly stated that useful feedback not only involves highlighting errors or deficiencies in their work, but also needs to contain clear instructions about how to do things correctly. Comments included, “*how you went in them* [assignments, sic], *explanations of answers/how to do them*” and “*what I did wrong and how to fix it/do it correctly*”. Most students seemed only to consider comments directly related to their work as feedback. So whilst the lectures in this subject were interactive and students asked questions at the end of most lectures, only 7% of students cited this as feedback.

Of those students who answered the survey, 10% interpreted the question “What is feedback” broadly, answering that feedback is “*one of the key things of the effective communication process*”, or simply “*my opinions*”. Only 7% of students said they had received constructive criticism on their work, with 17% stating that they had received comments on their progress in tutorials or elsewhere. Around 15% of students claimed to have received no feedback at all.



**Figure 1.** Major themes from student responses to the two questions at UM

#### *4.1.3 Comparison between lecturer and student views*

The lecturer thought that the most valuable feedback was provided via interaction with tutors in the tutorials coupled with the weekly assignment marks and comments. This gave the student an indication of their progress after working through the material in the tutorial and they could incorporate the tutor's feedback.

Given the weekly interaction with tutors, the small number of students who said they had received feedback during tutorials was surprising. This coupled with the even smaller number of students who stated that interaction in lectures was feedback, seems to suggest that comments that are not directly related to a piece of assessment are not considered to be feedback.

It is also interesting that the students who said that "ways to improve" was valuable feedback, seemed to not think that they had received this. For example, fully worked solutions to all assignment questions were provided so students either did not access these or thought these did not show them a way to improve.

### ***Swinburne University of Technology***

#### *4.2.1 Lecturer view of feedback provided*

The students were provided with the following feedback opportunities: Students

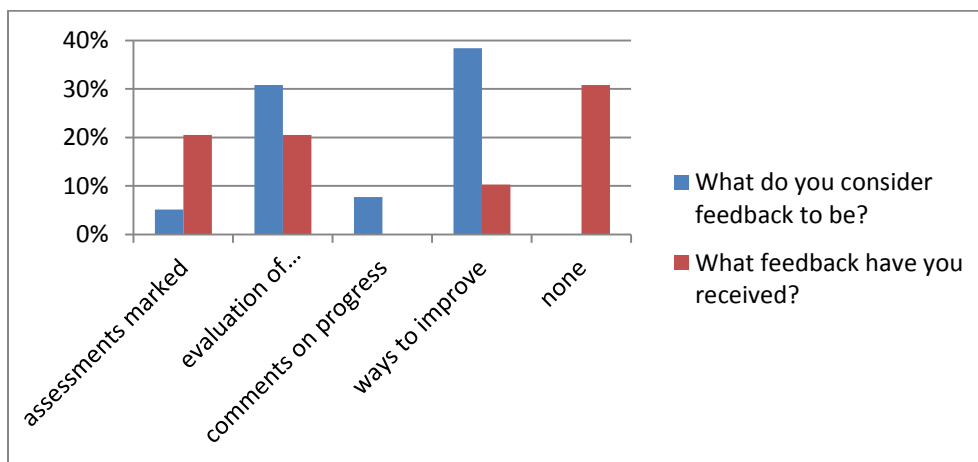
- were given the opportunity to view their marked diagnostic test (held in the first tutorial, shown in the second tutorial)
- were given the opportunity to review their two one-hour tests in lectures
- received immediate notification about which questions were correctly or incorrectly done on the 12 weekly online assignments. The best of three attempts counted towards their grade. Note that no full solutions were made available.
- received an individual study plan after each assignment on most topics, detailing which topics to revise (generated by the online assessment system)
- could visit the mathematics help centre for drop in support
- were able to ask the lecturer questions for 15 minutes following each lecture. The lecturer was also available for consultation in the mathematics help centre.

Note that the student evaluation of teaching survey at SUT does not include a question on “feedback”.

#### 4.2.2 Student view of what feedback is, and what feedback they received

Six of the 39 respondents at SUT thought “feedback” related to student feedback on the quality of teaching – they did not refer to their own learning in their comments. Figure 2 shows themes emerging from the responses of the remaining 33 students.

*Ways to improve* was a recurring theme when students defined feedback, with 45% of the students commenting that this is a role of feedback. However, only 12% reported having received such feedback, with most specifically mentioning the study plan. Nearly half of the students (48%) mentioned that *evaluation of performance* and *marks* are feedback, and just over half of all students said they had received this type of feedback.



**Figure 2.** Major themes from student responses to the two questions, at SUT

Although 24% of students mentioned a word such as *right*, *wrong*, *correct*, *good*, *bad*, *mistake* or *error* in their definition of feedback, none repeated these words in their description of feedback received. Finally, more than a third of students claimed not to have received any feedback.

#### 4.2.3 Comparison between lecturer and student views

There appears to be a clear mismatch between student and lecturer views of what feedback is. Students also commented on feedback they had not received, or what they didn’t like about the feedback they had received. The policy in this subject is not to return tests to students, but to allow students to view their tests in a lecture. The students appeared to be unhappy that they were not able to spend more time looking through their tests in order to identify where they had gone wrong. Also, students complained that the electronic assignment system was lacking a “human element”, as the following student comment shows:

*Feedback to me is communication about my efforts towards the subject. We get some viewing our corrected test papers. Though with the online assignments the process is indirect and has no human element, so feedback is difficult.*

Students, in particular, wanted to see detailed, worked solutions for the questions on the online assignments. Unfortunately the commercial software used does not provide



worked solutions. What we can learn from these student responses is that the study plan is seen as very useful, but also that consideration may need to be given to the provision of full worked solutions in the future.

### ***The University of Western Sydney***

#### ***4.3.1 Lecturer view of feedback provided***

Opportunities for feedback in this subject were:

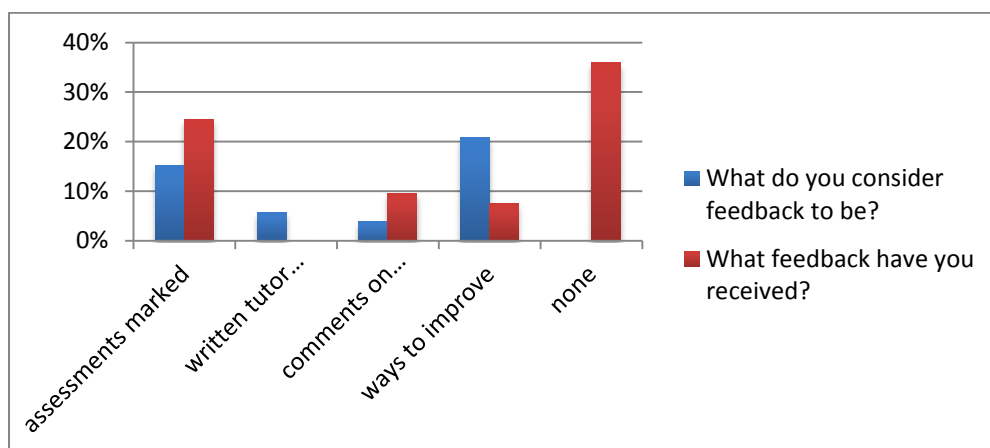
- Three class tests, marked and returned to students. At the time of taking the survey, the first test had been marked and returned to them.
- Feedback from tutors in weekly tutorials.
- Special support workshops run by mathematics support staff.
- The lecturer was available for consultation each week, and also available for questions during the break in the lecture and after the lecture.
- Online mathematics revision on most topics with immediate marking.

At UWS, the end of semester feedback on teaching survey contains the question “I was able to learn from feedback I received in this unit<sup>4</sup>”. The score for this question was 3.4 out of 5, where 5 means “strongly agree” and 3 means “neutral”.

#### ***4.3.2 Student view of what feedback is, and what feedback they received***

In the UWS survey, 15% of students considered marked assessment as feedback, with 5% mentioning written comments on assignments as feedback, see Figure 3. Receiving verbal comments on their progress or comments in tutorials was listed as feedback by 4% of students, with many more students (21%) explicitly naming “ways to improve” or “constructive criticism”.

Of the students surveyed, 8% stated they had received constructive criticism on their work with 9% saying they had received comments on their progress in tutorials or elsewhere. Of the students who answered the question on whether they had received feedback, 36% claimed to have received no feedback. Some students (16%) interpreted the question “What is feedback” broadly or gave their own feedback as a response. For example, “An evaluation of services offered”.



**Figure 3.** Major themes from student responses to the two questions, at UWS

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<sup>4</sup> Unit means subject in this context

### 4.3.3 Comparison between lecturer and student views

At the time of the survey, Test 1 results were available but many students had not collected their marked tests and so did not know what they had done well and where they needed to improve. Despite this, we note that it is this type of feedback that was recognised most in the survey responses.

The online revision, with its many questions, was not mentioned at all in survey responses. This raises the question if it is used by many students. Also, while there were many opportunities for feedback, most were poorly accessed and the only compulsory activity through which feedback was provided, the test, was the one that was most often mentioned. “Improvement” was the most common theme in what students wanted from feedback, yet most opportunities for improvement were not utilised. This could illustrate the unwillingness of some non-mathematics major students who are required to do mathematics as part of their degree to engage in any non-compulsory activity.

## Discussion and conclusion

Sadler’s [1] three conditions for effective feedback, understanding the required level of performance, comparing your own performance to this required level, and engaging in action to lead to a reduction of this gap, were visible in students’ responses. Though few mentioned *pass*, many wrote *results* or *marks* from assessments. Some students aim for the 50% pass mark, as one comment clearly illustrated: “*Helpful information to help me pass the unit*”. Some students, perhaps many students, expect in feedback information on how their performance compares with the pass mark. Other students aspire to high marks and value feedback as a tool to help them achieve their goals. However, no matter what the goal, feedback appears to be associated with *marks* rather than *learning*.

Improvement was a common thread in responses, and we can only hope that once armed with such information students will act on it and take part in Sadler’s third condition: engaging in action to improve. Engagement in such actions was not measured in this study. Future work will be to follow up on the use of feedback by first year mathematics students and to measure how, and if, students actively engage in the various activities that we see as providing feedback. This may also indicate to what level our students are actually self-regulated learners.

When we wrote the survey questions we expected students to have at least some sort of idea what feedback is, and that they would be able to match this with what they had actually received. Through the open ended nature of the survey questions we tried to extract this information from the students. What we did not realise is that with no guidance students struggled with the definition of feedback and with the description of feedback received. This appears to have led to a number of students not interpreting the questions the way we anticipated.

Finally, teaching staff see a much broader range of student-staff and student-resource interactions as providing feedback than students. Evidence for the difference between student and staff perceptions of what constitutes feedback may be found in the following two quotes in response to the question on what feedback had been received: “*No direct feedback; I know from my marks I need to improve though*”, and “*I’ve had no direct feedback. There was a little indirect feedback on my first test paper*”. This supports our contention that student responses on feedback on teaching evaluation questionnaires should be questioned. At the same time, we should ask ourselves how we can better align our perceptions of feedback with those of our students. Let’s hope this is possible without the rebranding exercise from [3].

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