

# *Student Perceptions of an Explicitly Criterion Referenced Assessment Activity in a Differential Equations Class*

## **Contributed Research Report**

### **Authors**

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### **Abstract**

This report presents the findings of a study into the perceptions held by students regarding the use of criterion referenced assessment in an undergraduate differential equations class. Students in the class were largely unaware of the concept of criterion referencing and of the various interpretations that this concept has among mathematics educators. Our primary goal was to investigate whether explicitly presenting assessment criteria to students was useful to them and guided them in responding to assessment tasks. The data and feedback from students indicates that while students found the criteria easy to understand and useful in informing them as to how they would be graded, it did not alter the way the actually approached the assessment activity.

### **Keywords**

differential equations, assessment experiment, criterion referenced assessment

### **Introduction**

Generally speaking, Australian Universities impose or very strongly encourage the use of criterion referenced or standards based assessment in the courses that they offer. At the authors' home institution this is no different with the University's Manual of Policies and Procedures stating that the University "has adopted a criterion-referenced approach to assessment where assessment is based on pre-determined and clearly articulated criteria and associated standards of knowledge, skills, competencies and/or capabilities." In a sense, this directive has been largely ignored in the context of many quantitative courses such as those in mathematics and science by offering justifications that in quantitative studies assessment responses are either right or they are wrong and that is sufficient for a criterion. In this study we report on the successful implementation of elements of criterion referenced assessment into a Differential Equations course that goes beyond simple "right-wrong" criteria while maintaining the mathematical integrity of the assessment program. Furthermore, we present findings based on quantitative and qualitative feedback from students regarding their perceptions of criterion referencing and how it is used in guiding their learning throughout the course.

It is important to place this study in context by comparing the assessment experiment with the methods previously used to assess students in the course. Over approximately the past 10 years, the course has been taught by a number of people, however the assessment strategy has essentially been to employ 1-2 assignments (problem solving tasks with a 2-4 week completion timeframe) and a mid-semester and final examination. These tasks generally contribute 30-40% (assignment) and 60-70% (examination) of the final grade for the course, respectively. Grading of all tasks has been quite traditional in the sense that the academic responsible for assessment writes their own set of "correct" solutions and assigns points or marks throughout the solutions corresponding with reaching certain points in the solution process.

In the assessment experiment reported on in this paper, we have attempted to maintain the previously employed assessment program as much as possible. In particular, we maintained progressive, non-examination assessment of 40% and used mid-semester and final examination contributing 60% of the students' final grades. However, we implemented an explicit criterion referenced method of grading students in the assignment tasks completed during semester. This involved presenting students with a set of criteria and standard definitions in addition to the actual problems to be solved. Students were provided with details of exactly how responses to the mathematical problems would be graded and how translation between the mathematics and the standards and criteria would be carried out.

Our goals in conducting this experiment fall into two main areas: to gauge students' perceptions regarding criterion referenced assessment and its usefulness, and to a lesser extent, effecting culture change among mathematics academics. With regard to students' perceptions, we investigated how students viewed the understandability and the usefulness of criterion referencing and how they employed the additional information provided to them via the criteria and standards definitions in directing their learning and assessment responses. Implicitly, we believe that such an investigation and its results can then be used to effect culture change among mathematics teachers at universities by changing the way they view criterion referenced assessment, taking CRA from a directive imposed by administrators to a useful tool for mathematics learning.

### **Introductory literature review and placement of this research**

Niss (1998, in Pegg 2003, p.228) notes that mathematics assessment identifies and appraises the knowledge, insight, understanding, skill and performance of a student. Pegg however points out that this is not in fact the reality of assessment in mathematics and that rather, it is most often concerned with reproduction of facts and computational skills or algorithms (Pegg 2003). It is our contention that this is how previous years' assessment programs for the course under investigation have been presented to students. In the assessment experiment discussed in this report, we attempt to explicitly link the subtasks of the assessment activities with the learning outcomes of the course, which include such concepts as knowledge, insight and understanding in addition to skills. In this way we believe that our assessment becomes more of an educational tool for students than it has been in previous versions of the course, and that it allows for a more "constructive alignment" (in the sense of Biggs, 1996) of the content, pedagogy and assessment.

Criterion referenced assessment involves determining the extent to which a learner achieves certain predetermined goals or criteria, importantly, without reference to the performance of others (Brown, 1988; Harvey, 2004; TEDI, 2006). The implementation of CRA involves the design or statement of a set of learning outcomes for a course, design of a program of assessment to obtain information about a student's performance in relation to the learning outcomes, and the presentation of a criteria set and definition of standards which serves to both inform students how their performance will be judged and to provide directions for assessors.

Pegg (2003) notes that while the movement towards assessment based on outcomes and standards (rather than individual comparison) did initially have some basis in research regarding student learning, the links remain tenuous. As such, there is debate among teachers and academics alike as to whether the claims regarding the benefits of criterion referenced assessment are supported by strong research. Through research such as that presented in this study, we attempt to provide a research base

that advocates the benefits and warns of the pitfalls of criterion referenced assessment in the undergraduate mathematics classroom.

### **Theoretical perspective/conceptual framework**

In this study we carry out descriptive research related to questions around student perceptions and criterion referenced assessment. This descriptive research involves statistical and textual analysis/synthesis of data collected from a student population undertaking a course in differential equations in an attempt to understand student perceptions and provide guidance for academic staff in undertaking more useful assessment in mathematics courses.

### **Methods**

We have used two primary data sources, one quantitative and one qualitative, in an attempt to address our research goals regarding student perceptions of criterion referenced assessment. The first source was a survey allowing free-text responses on two questions of interest, while the second was a 10-item survey using a 5 level Likert scale. Both surveys were conducted at the end of the course of study, following the provision of feedback to students on the criterion referenced items and also following the post mid-semester exam feedback sessions. All 56 students in the cohort were offered the chance to respond, with a 30% response rate achieved. Another source of data that will be commented upon, although to a lesser extent, are the assessment responses themselves. Numerical and statistical analyses of the Likert-survey were conducted, while textual analysis and synthesis was carried out on the free-text responses.

### **Results**

Quantitative data collected via the second of the student surveys indicates that while students found assessment criteria easy to understand and useful in informing them as to how they would be graded, it did not alter the way they actually approached the assessment activity. Qualitative feedback from almost 100% of respondents indicated that in general the criteria provided were not used to determine how a student would approach individual questions or the assessment tasks as a whole. Interestingly, a similar percentage of students stated that they found CRA beneficial as it made the process of allocating scores by graders much clearer. A small percentage of students indicated that they did refer to the criteria sheets after the tasks were graded in order to get a different, higher level representation of where they had made errors in their responses.

### **Implications/Applications**

This research study has opened up new questions for future research. For example, we are now considering the impact on graders/academics and the usefulness they perceive in employing criterion referenced assessment.

With regard to application in the classroom in the future, both the qualitative and quantitative data indicate that students and graders alike, need to be explicitly informed exactly why they are provided with criteria and how they can be used to assist learning. In particular, guiding them in their response attempts (showing them what the grader will deem to be “important”) and also aiding them in understanding the feedback they receive following the grading of their work. Furthermore, the actual construction of the criteria and standards is by no means straight forward – but it is important, because these are exactly the types of judgements we are normally making in an implicit, content-

centred manner. Academic staff need to be closely guided in the development of these elements of any criterion referenced assessment strategy.

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