



Feedback on students' performance: A possible way of reducing the negative effect of math anxiety in higher education



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ABSTRACT

The aim of this study was to investigate the effectiveness of a formative assessment system in improving students' learning. This system involved giving feedback to students regarding the errors they made in a series of assignments performed during a course. Participants were 166 students enrolled in a core course of the degree in psychology offered by the University of Barcelona. Attendance at feedback classes was found to be positively correlated with students' grades, whereas the correlation between math anxiety scores and final exam grades was not significant. Exam grades were only predicted by the 'perceived usefulness of feedback' factor, suggesting that feedback may have helped to reduce the negative impact of math anxiety on students' academic achievement.

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1. Introduction

Formative assessment is defined as "a process of appraising, judging or evaluating students' work or performance and using this to shape and improve their competence" (Tunstall & Gipps, 1996, p. 389). Its purpose is to provide direct feedback about the learning and teaching process, and it can have beneficial effects for both students and teachers (Rolle & McPherson, 1995; Wass, Van der Vluten, Shatzer, & Jones, 2001). It is generally acknowledged that formative assessment improves students' learning through the provision of information about their performance (Black & Wiliam, 1998; Hattie & Timperley, 2007).

The core of formative assessment (i.e., assessment for learning) is, therefore, feedback. Feedback has been described as "information with which a learner can confirm, add to, overwrite, tune, or restructure information in memory, whether that information is domain knowledge, meta-cognitive knowledge, beliefs about self and tasks, or cognitive tactics and strategies" (Winne & Butler, 1994, p. 5740). Without feedback from teachers, students' mistakes go uncorrected and good performance is not reinforced, which may adversely affect not only students' motivation but also their grades (Bose & Rengel, 2009).

In the present study a formative assessment system was developed and implemented in the context of a *Research Design* course, a second-year core subject in the degree in psychology offered by the University of Barcelona. The specific aim was to

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investigate the effectiveness of this system in improving students' learning. The *Research Design* course is high in statistical content and requires numerical reasoning. It is therefore difficult and unpleasant for many students, who either fail to pass the exams or abandon the course because they feel incapable of passing. In a previous study, [Núñez-Peña, Suárez-Pellicioni, and Bono \(2013b\)](#) found that most university students who failed to pass a *Research Design* course showed a high level of math anxiety and negative attitudes towards this subject. Importantly, math anxiety has been found to be associated not only with negative attitudes towards mathematics but also with poor academic outcomes in the subject and low confidence regarding the ability to learn math ([Jasen, Louwese, Straatemeier, Van der Ven, Klinkenberg, & Van der Maas, 2013](#)).

In the formative assessment system described in the present study, students undertook a series of assignments during the course and were provided with feedback about their performance. The syllabus for the *Research Design* course comprised seven topics, each focusing on a type of research design. Each design was worked on in three sessions spread across one week: the first session was a lecture, the second was a practical session, and the third was a feedback session. The practical sessions required students either to solve a problem or to perform a computer analysis, working in small groups in class. At the end of these sessions the students handed in either a set of solutions to the problem they had worked on or the results and their interpretations of their data analysis. These assignments contributed to the final grade for the course (see Materials section). The materials used in these practical sessions were developed with the aim of improving the process through which statistics were taught and learnt, following the recommendations made in several studies related to statistics education (for a review, see [Garfield & Ben-Zvi, 2007](#)). Four of these recommendations are as follows: First, practical courses are considered to be more effective than theoretical ones ([Becker, 1996](#)); second, the use of statistical software and computing equipment to analyze data enables students both to interact with data and to visualize complex concepts, helping them to solidify their understanding of important concepts ([Marasinghe, Meeker, Cook, & Shin, 1996](#); [Weissglass & Cummings, 1991](#)); third, using cooperative groups in class to work on assignments has positive effects on students' grades, because it encourages students to argue convincingly for a particular approach and helps them become more involved in their own learning ([Giraud, 1997](#); [Keeler & Steinhorst, 1995](#)); and fourth, using real data increases students' interest and motivation towards the subject ([Garfield, 1995](#); [Sciutto, 1995](#)).

In our formative assessment system, feedback sessions were held the day after the practical session. During the feedback session the practical exercises that had been performed the previous day were corrected by the teacher and the main results and most frequently committed errors (detected by the teacher when correcting students' assignments) were drawn attention to. The ultimate aim of these sessions was that students gained information about their understanding of the course content in order to improve their knowledge and skills and increase their self-confidence in the subject. The correct solutions to the work carried out in the practical classes were also made available to students via the course website.

During the 2012–2013 academic year the formative assessment system was implemented in the *Research Design* course with the general aim of improving students' academic achievement and the specific aim of minimizing the negative impact of math anxiety on their academic performance. The related study goal was to examine whether this system, consisting mainly in giving students feedback on their errors and correcting their misconceptions about statistics, would help them become more confident in relation to learning this subject and, thus, lead to improved grades. We expected that this system would be especially useful for high math-anxious students, who are particularly affected when facing a test situation. It is generally agreed that the lower grades achieved by high math-anxious students on mathematics exams are not merely a reflection of their math knowledge but also of their anxiety ([Maloney, Schaeffer, & Beilock, 2013](#)). In research conducted during the 2010–2011 academic year we found that students who did not pass the *Research Designs* course showed a higher level of math anxiety, specifically of math test and math course anxiety ([Núñez-Peña et al., 2013b](#)). In addition, a stepwise multiple regression analysis testing the relationships between math anxiety, math attitudes, and grades yielded an interesting finding, namely that students' final exam grades were best explained by the math course anxiety factor.

In order to assess whether the formative assessment system was able to reduce the negative impact of math anxiety on students' performance (i.e., on their course grades), we first compared the correlations between math anxiety scores and final exam grades that were obtained during the 2012–2013 course with those obtained during the 2010–2011 course (published in [Núñez-Peña et al., 2013b](#)). We expected to observe a considerable reduction in the strength of the correlations between math anxiety and students' achievement in the 2012–2013 course. We then used a stepwise multiple regression model to test relationships between math anxiety, math attitudes, the perceived usefulness of feedback sessions, and final grades, and compared these relationships with those observed during the 2010–2011 academic year. We expected to considerably reduce the regression coefficient for the math course anxiety factor in the model for 2012–2013, which would suggest that the feedback system implemented during that academic year was useful for minimizing the negative impact of math anxiety on students' grades in the *Research Design* course.

2. Methods

2.1. Participants

The study sample comprised 166 students who were enrolled during the 2012–2013 academic year in the *Research Design* course that forms part of the degree in psychology offered by the University of Barcelona. One hundred twenty-one were female (72.89%) and 45 were male (27.10%). In terms of age, 42.77% of participants were aged between 18 and 20 years old,

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