

Using Differentiated Feedback Messages to Promote Student Learning in an Introductory Statistics Course

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Abstract: In light of the regulatory focus (RF) theory, an intervention was designed to promote student learning through differentiated feedback and then implemented in an undergraduate statistics course. Sixty-seven students were randomly assigned to receive the feedback that either fit or did not fit their RF. Results revealed a significant interaction between an individual's RF and the type of feedback received after controlling for the student's prior achievement. In particular, the students demonstrated better performance when receiving the fit feedback than the non-fit feedback. Further analysis of different performing groups showed that this identified interaction was significant only for the middle performing students, but not for the lower or higher performing groups. The findings suggested that the student's RF may moderate the impact of feedback on students' statistics performance, and this moderation pans out differently depending on the student's previous achievement.

Introduction

Feedback is often considered as an essential component in learning and teaching. Extant literature indicates that to become effective, feedback must be adaptive (Nicol, 2010) and be addressed in the context in which learning occurs (Hattie & Timperly, 2007); otherwise, feedback would produce inconsistent effects on learning outcomes due to the variations in student characteristics (e.g., Malachowski, Martin, & Vallade, 2013).

Unfortunately, many undergraduate classes afford limited opportunities for the instructors to provide adaptive feedback for each student (Voelke, 2013). The content of the feedback is often neither sufficient (Jacobs & Chase, 1992) nor adaptive (Nicol, 2010) to have desirable effects on learners. Moreover, very little effort has been made to examine the effectiveness of feedback (Price, Handley, Millar, & O'Donovan, 2010).

This study attempts to address these challenges by implementing a differentiated feedback strategy in an introductory statistics class in light of the regulatory focus (RF) theory (Higgins, 1997). In particular, we designed differentiated feedback to become aligned with the student's achievement levels and framed the feedback so that it would either fit or not fit the learners' RF. The major goal of this study is to determine to what extent the fit between the individual's RF and the type of feedback would affect students' course performance. We were also interested in whether such effect would differ for students with different previous achievement in statistics.

Regulatory focus

According to regulatory focus (RF) theory (Higgins, 1997), there are two distinct systems of self-regulation—i.e., *promotion* and *prevention*—which regulate goal-directed behaviors. The *promotion* system is mainly concerned with aspirations, accomplishments and advancement. Individuals with a promotion focus are inclined to focus on “the pleasurable presence of positive outcomes (Higgins et al., 2001, p. 4)”, and therefore, use promotion strategies, such as risk taking and eager advancement, to achieve ideal goals. In contrast, the *prevention* system is primarily concerned with duties, obligations, and responsibilities. Individuals with a prevention focus tend to be prudent and precautionary to avoid negative outcomes (Crowe & Higgins, 1997).

Regulatory focus influences the motivational effects of feedback via regulatory fit (Higgins, 2000). When there is compatibility between an individual's goals and the types of feedback provided, regulatory fit occurs, and that leads to an increase in motivation and performance (Higgins, 1997). Past studies have examined regulatory fit in various fields (e.g., Florack & Scarbis, 2006) and in higher education (e.g., Shu & Lam, 2011). These studies indicate that a message can motivate people more effectively in fit conditions compared to non-fit conditions.

Methods

Participants and context

The study was conducted in a three-credit undergraduate course, Elementary Statistics, offered to the whole campus by the Department of Mathematics and Statistics at a state university in a Midwestern state in the US. Due to its large enrollment, the class was divided into 13 sections, with approximately 30 students each. Six

instructors were assigned to teach this course, with each teaching up to three sections. Since this study was a pilot project instead of a full-scale implementation, students from three sections ($n = 90$) taught by the same instructor participated in this study.

Design and procedures

In the first week of the semester, we invited the 90 students to complete a Regulatory Focus Questionnaire (RFQ; Higgins et al, 2001) and received 67 complete responses with a completion rate of 74.4%. Based on the responses, 46 students were identified as having a promotion focus, the other 21 students a prevention focus.

We randomly assigned the students with a promotion focus to receive either promotion or prevention feedback and repeated the same procedure to the students with a prevention focus (see Table 1). Taken together, 35 students received the “fit” feedback and 32 students received the “non-fit” feedback in this study.

Table 1: Students receiving promotion or prevention feedback through random assignment.

	Students with Promotion Focus	Students with Prevention Focus	Total
Receiving Promotion Feedback	24 (fit)	10 (non-fit)	34
Receiving Prevention Feedback	22 (non-fit)	11 (fit)	33
Total	46	21	67

Over the study, five quizzes were administered approximately every three weeks to evaluate student performance. The students took their first and second quizzes in the third and sixth weeks of the semester. The average scores on these quizzes were considered as the baseline data for student achievement prior to the intervention. After the second quiz, the students started to receive performance feedback about one week after each quiz. They would also receive a quiz reminder about a week before each quiz. Both the performance feedback and the reminder were differentiated to match either the promotion focus or the prevention focus. Moreover, the performance feedback was differentiated to align with the students’ quiz performance levels.

Measures

Regulatory focus

To assess the students’ RF, we used the Regulatory Focus Questionnaire (RFQ), which was composed of eleven Likert items asking the respondents’ preference for promotion or prevention tasks (see Higgins et al, 2001).

Prior achievement

Students’ prior achievement was determined by the average scores of Quiz 1 and Quiz 2.

Statistics performance

Statistics performance, evaluated based on the average scores of Quiz 4 and Quiz 5, was treated as the dependent variable in this study. Quiz 3 was excluded from statistics performance because its format was different from other quizzes.

Findings

Baseline performance

An independent-sample t test suggested no significant difference in prior achievement between students assigned to the fit condition and those in the non-fit condition ($M_{fit} = 69.94$, $M_{non-fit} = 68.41$, $t(65) = .37$, $p = .72$).

Overall effect of differentiated feedback on statistics performance

An analysis of covariance (ANCOVA) was conducted to determine the effects of the feedback on students’ achievement. The dependent variable was the students’ statistics performance. The independent variables were the students’ RF and the type of feedback. The covariate was their prior achievement. The Levene’s test was non-significant ($p = .10$), suggesting the assumption of homogeneity of variances was not violated. The results showed a significant interaction between the individual’s RF and the feedback type ($F(1, 62) = 5.09$, $p < .05$, $\eta_p^2 = .08$), suggesting that matching the feedback to the individual’s RF might significantly affect student learning (see Table 2). Subsequent analysis revealed that the fit group had higher statistics performance ($M = 61.80$, $SD = 23.81$) than the non-fit group ($M = 53.98$, $SD = 34.35$), although the difference was not significant ($t(54.60) = 1.07$, $p = .29$).

Analysis of students from different achievement groups

Students were divided into higher ($n = 23$), middle ($n = 23$), and lower ($n = 21$) performing groups based on their prior achievement in statistics. An ANCOVA was conducted within each group. The results of the Levene's tests were non-significant for all the three groups (all p 's $> .10$). Results are presented in Table 2.

Table 2: ANCOVA results for the whole sample and the subgroups.

	n		df	F	p	η_p^2
Whole sample	67	RF	1	8.691	.005**	.123
		Feedback	1	10.166	.002**	.141
		RF * Feedback	1	5.091	.028*	.076
Higher performing	23	RF	1	.050	.825	.017
		Feedback	1	1.156	.297	.003
		RF * Feedback	1	.305	.587	.017
Middle performing	23	RF	1	3.592	.074	.166
		Feedback	1	9.798	.006**	.352
		RF * Feedback	1	7.870	.012*	.304
Lower performing	21	RF	1	4.802	.044*	.231
		Feedback	1	2.004	.176	.111
		RF * Feedback	1	2.055	.171	.114

Note: * $p < .05$. ** $p < .01$.

For the higher performing group, neither the feedback nor the students' RF was found to have a significant impact on the students' statistics performances. The interaction between the two variables was not significant, either (all p 's $> .10$). As Figure 1 shows, the students from the fit group had slightly lower scores than those in the non-fit group on every quiz of the semester, which seemed to be inconsistent with what the RF theory predicts.

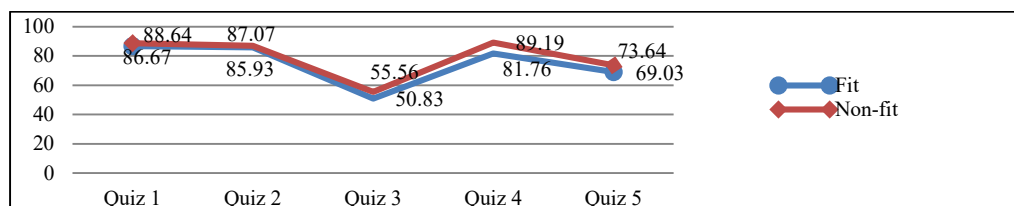


Figure 1. Average Score Comparison for Higher Performing Group.

For the lower performing group, the individual's RF was found to be significantly associated with the student's statistics performance. But neither the feedback nor its interaction with the RF was significant (all p 's $> .05$). The students from the fit group had lower performance on Quiz 1 than the non-fit group, but they consistently achieved higher scores on the subsequent quizzes than their counterparts from the non-fit group (See Figure 2). Notably, the achievement gap between the fit and non-fit groups was larger on Quiz 4 and Quiz 5 than the first three quizzes. So, there might be subtle effects of the differentiated feedback ($F(1, 16) = 2.055$, $p = .171$, $\eta_p^2 = .114$) that are worth investigating in the future.

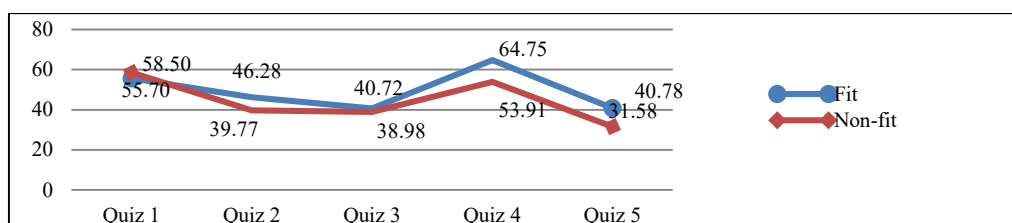


Figure 2. Average Score Comparison for Lower Performing Group.

Interestingly for the middle performing group, the student's RF was not significantly related to their statistics performance, but the feedback seemed to have a significant impact ($F(1, 18) = 9.798, p = .006, \eta_p^2 = .352$). Moreover, the interaction between the feedback and the individual's RF was significant ($F(1, 18) = 7.870, p = .012, \eta_p^2 = .304$). On the first three quizzes, the students from the fit group had comparable average scores with the non-fit group, but they outperformed their counterparts on Quiz 4 and Quiz 5, as shown in Figure 3. Further analysis indicated that the students who received the fit feedback had higher performances than those who received the non-fit feedback, although the difference was not significant ($p > .05$).

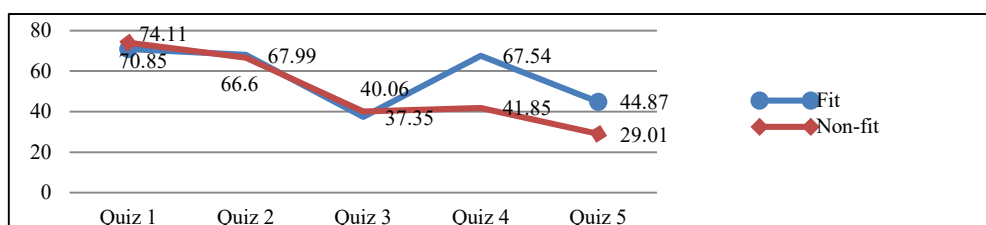


Figure 3. Average Score Comparison for Middle Performing Group.

Conclusions and implications

This pilot study applied the RF theory in an undergraduate course setting and generated empirical evidence about the extent to which the individual's RF could moderate the impact of feedback on student achievement. Results suggested that the alignment between the students' RF and the type of feedback could significantly affect learners' achievement. The findings further suggested that the learners' prior achievement could play a role in their responses to the feedback. In the middle- and lower-performing groups, the students receiving the fit feedback demonstrated better course performance than those receiving the non-fit feedback, but the pattern was not observed with the higher-performing group. When designing feedback, it is important to consider both the learners' RF and their prior achievement in order to improve their performance. It also seems necessary to explore better strategies to motivate the higher-performing students.

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