

## **Gender differences in the functionality of regret on academic performance**

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### Introduction

Despite increases in female enrollment levels in engineering programs, the gender gap is still significant. Women accounted for approximately 23% of first-year students who desire to major in engineering programs in 2014 in the U.S. [1], and the actual female enrollment levels in engineering programs have been from 17 to 22% between 2002 and 2016 [2]. A better understanding of gender differences in early-career pathways will help develop a future intervention to encourage women to enter and stay in this field.

The current study was conducted as part of a broader NSF grant investigating how counterfactual thinking about “what might have been” may serve as an intervention tool in promoting academic success for engineering students in their first-year courses. Additionally, we pursued exploratory analyses to investigate other dimensions that may correlate with academic success. The analyses presented here explored the relationship between gender, regret, and academic performance. The initial findings of the current research suggest a potential gender difference in the functionality of regret on academic performance in early engineering courses.

Regret is the emotion that arises from upward counterfactual thinking or imagining “what might have been” had one acted differently [3]. These thoughts involve the comparison between an actual past event and some better alternative. Regret is composed of affective and cognitive components, and each component is related to distinct consequences [4]. The counterfactual comparison is the cognitive component, and the associated negative arousal is considered the affective component. Regret can be a functional emotion; despite being affectively negative, regret offers preparatory functions for future behaviors and helps people better understand themselves and the context of their aversive experiences [5], due to its association with counterfactual thinking.

Counterfactual thinking can benefit future behavior by offering a behavioral script for self-improvement [6]. The functionality of regret is related to its affective and cognitive components; the negative affect aroused by counterfactuals can increase strategic planning and motivation to promote future improvement [7], whereas the cognitive component is related to functional consequences like planning and self-improvement [4]. However, regret and counterfactual thinking can also be dysfunctional. The affective component of regret is often associated with negative outcomes like reduced well-being and avoidant responses to learning opportunities [8]. Additionally, people are often unable to accurately identify the cause of negative events, and counterfactual thinking can lead to misattributions of blame [9,10]. People also tend to mentally alter aspects of the situational context rather than their behaviors, which can interfere with the functionality of counterfactual thinking by no longer offering a script for self-improvement [11]. In the context of academic performance, counterfactuals can act as excuses to improve self-esteem [12] and create a false sense of competence [13]. Consequently, counterfactuals may decrease motivation to improve academic performance.

There have been very few findings of gender differences in regret experiences, and any differences identified seem to be domain specific. In the domain of romantic relationships,

women and men experience different patterns of action and inaction regrets [6]. Men focus more on inaction regrets or regrets about things they could have done differently (rather than things they should not have done). In contrast, women's romantic regrets are more evenly distributed between these two types of regrets. Other research has suggested a potential gender difference in the frequency of action versus inaction regrets, but these findings were inconclusive [14]. The current findings offer preliminary evidence of another way regret may differ by gender. Specifically, we were interested in identifying if regret experiences would lead to greater course improvement for men or women.

## Methods

As part of a larger longitudinal study, we collected data across three years using separate samples each year. Every fall semester, we recruited participants to complete up to four surveys throughout the semester. Since these surveys were nearly duplicated across samples, we merged the data collected across the three years to have one large sample. The surveys included additional variables not presented in this paper, as they were irrelevant to the current research question. The main purpose of this longitudinal research was to test the impact of a psychological intervention on students' performance in early-engineering courses. However, combining our datasets has enabled us to explore other research questions that investigate gender differences in regret experiences and course performance.

Participants were first-year students at a mid-sized state university in the Midwest of the United States enrolled in calculus-based physics, calculus, or introductory computer science. These courses were identified as difficult entry-level courses that were core to the engineering curriculum. Participants were invited via email and completed all the surveys online. Of the 646 participants who responded to at least one of our surveys, 428 (237 male and 191 female) students adequately provided their gender, first exam grade, and feelings of regret.

Participants provided informed consent and a FERPA release, which provided us access to their academic record and final course grade. In the intake surveys, all participants provided their demographic information.

After the first exams had been returned, participants who had completed the intake survey were invited to the post-exam survey. They provided their grade on the first exam as a percentage (0-100) and then completed a measure of their feelings of regret. We used the Regret Elements Scale [4], which assesses the affective and cognitive components of regret. Participants were asked to rate their current feelings of regret about the first exam. Five items measured the affective components of regret (e.g., "I feel like kicking myself.") whereas the other five examined cognitive regret (e.g., "I should have behaved differently.") using 7-point scales from 1 (strongly disagree) to 7 (strongly agree).

After final grades were submitted for the semester, we contacted the course instructors and asked them to provide course grades for participants who had signed a FERPA release. Letter grades were converted into numeric values on a 4-point scale.

## Results

We examined whether the functionality of regret on academic performance differs by gender. All regret values were standardized. We regressed the course grade on the interaction of affective or cognitive regret ratings and gender while controlling for first exam grade.

There was a significant main effect for gender,  $\beta = -0.16$ ,  $S.E. = 0.08$ ,  $p = 0.04$ , 95% C.I. = [-0.31, -0.01], suggesting that female students overall received better grades than male students above and beyond first exam performance and affective regret. There was not a significant effect of affective regret on course performance overall,  $\beta = 0.06$ ,  $S.E. = 0.06$ ,  $p = 0.34$ , 95% C.I. = [-0.06, 0.18].

Most notably, the interaction of affective regret and gender (0 = female, 1 = male) was marginally significant,  $\beta = -0.14$ ,  $S.E. = 0.08$ ,  $p = 0.07$ , 95% C.I. = [-0.30, 0.01]. This interaction implies that the effect of affective regret on course grade differs for women and men. As shown in Figure 1 (see also Table 1), among female students, affective regret had a non-significant positive impact on their course grades,  $\beta = 0.06$ ,  $S.E. = 0.06$ ,  $p = 0.34$ , 95% C.I. = [-0.06, 0.18], such that when female students' affective regret was higher (+1 S.D.), their course grades tended to be higher ( $M = 2.99$ ) than when female students' affective regret was lower (-1 S.D.,  $M = 2.87$ ). In contrast, among male students, affective regret had a non-significant negative influence on their course grades,  $\beta = -0.08$ ,  $S.E. = 0.06$ ,  $p = 0.17$ , 95% C.I. = [-0.20, 0.04], such that when male students' affective regret was higher (+1 S.D.), their grades were lower ( $M = 2.69$ ) than when male students' affective regret was lower (-1 S.D.,  $M = 2.85$ ). These outcomes suggest male students may be more susceptible to the negative consequences of affective regret for academic performance relative to female students.

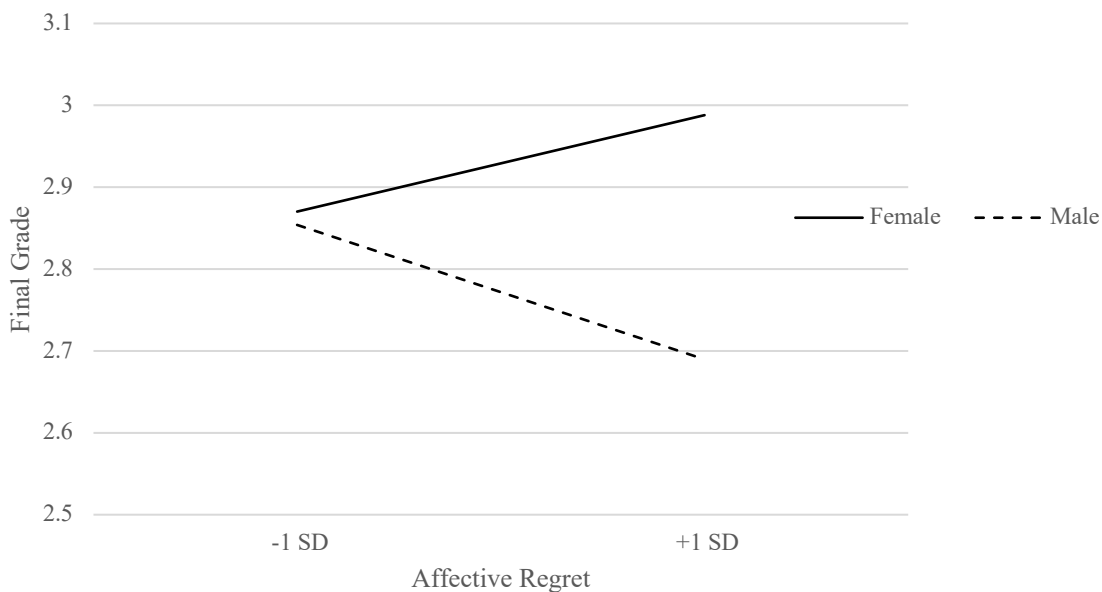


Figure 1. The gender difference in the effect of affective regret on final grade

In a second regression, we regressed performance on cognitive regret, gender, and their interaction, while controlling for exam 1 grade. The main effects of gender,  $\beta = -0.16$ ,  $S.E. = 0.08$ ,  $p = 0.04$ , 95% C.I. = [-0.31, -0.004], as well as cognitive regret,  $\beta = 0.12$ ,  $S.E. = 0.06$ ,  $p = 0.06$ , 95% C.I. = [-0.01, 0.24], were significant. The main effect for gender indicates better overall performance of women in the course than men, and the main effect of cognitive regret demonstrates that cognitive regret positively impacted course grade for women above and beyond first exam scores.

As with affective regret, the functionality of cognitive regret on academic performance appeared to differ by gender. The effect of cognitive regret on course grade also differed by gender. The interaction of cognitive regret and gender influenced course grade,  $\beta = -0.19$ ,  $S.E. = 0.08$ ,  $p = 0.02$ , 95% C.I. = [-0.34, -0.03]. In other words, cognitive regret may improve performance for female students but decrease performance for male students. As shown in Figure 2 (see also Table 1), cognitive regret marginally affected course grade for female students,  $\beta = 0.12$ ,  $S.E. = 0.06$ ,  $p = 0.06$ , 95% C.I. = [-0.01, 0.24], such that the more female participants reported cognitive regret, the greater course grade they received (+1 S.D.,  $M = 3.05$ ; -1 S.D.,  $M = 2.81$ ). However, cognitive regret had a non-significant negative influence on course grade for male students,  $\beta = -0.07$ ,  $S.E. = 0.06$ ,  $p = 0.23$ , 95% C.I. = [-0.18, 0.04]. The more male students felt cognitive regret, the lower course grade they received (+1 S.D.,  $M = 2.71$ ; -1 S.D.,  $M = 2.85$ ). These findings suggest that female students experienced the functional consequences of regret in regard to academic performance, while male students were negatively impacted by the experience of regret.

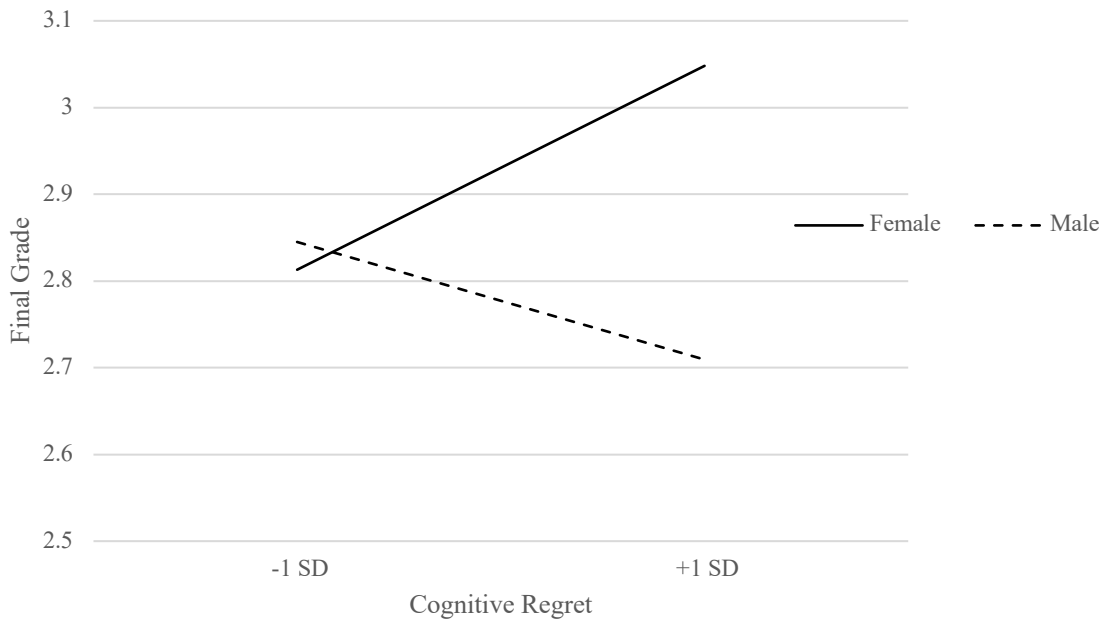


Figure 2. The gender difference in the effect of cognitive regret on final grade

Table 1. A summary of the results

Full Regression Models				Simple Slopes		
Predictor	Outcome	Effect	<i>p</i> -value	Gender	Effect	<i>p</i> -value

		Size ( $\beta$ )		Size ( $\beta$ )		
Affective Regret		0.06	0.34 <sup>ns</sup>	Female	0.06	0.34 <sup>ns</sup>
Gender	Course	-0.16	0.04 <sup>*</sup>			
Affective Regret X Gender	Grade	-0.14	0.07 <sup>†</sup>	Male	-0.08	0.17 <sup>ns</sup>
Cognitive Regret		0.12	0.06 <sup>†</sup>			
Gender	Course	-0.16	0.04 <sup>*</sup>	Female	0.12	0.06 <sup>†</sup>
Cognitive Regret X Gender	Grade	-0.19	0.02 <sup>*</sup>			

*Note.* Female and male were coded as 0 and 1 respectively. ns = not significant, <sup>†</sup> <0.1, <sup>\*</sup> <0.05.

## Discussion

The present research suggests that both affective and cognitive regret were functional for female students but dysfunctional for male students. These findings extend previous research that promotes the functional consequences of regret and highlights how these benefits may be specific for women but not men. Past research has shown some gender differences in types of regrets and regret intensity, but there are generally few gender differences identified in the literature for regret experiences [6]. In the current research, our exploratory analyses provide initial evidence that the functionality of regret may differ by gender.

However, it remains unclear why regret would be relatively more functional for female than male students in the current research. Regret is a negative emotion aroused by counterfactual thinking that typically motivates people to enhance future performance [7]. One potential explanation for these findings is that women may have a better memory of their regret experiences and be more sensitive to regret compared to men. According to Bloise and Johnson [15], women recall both neutral and emotional information more than men. They claim that this may be because women may experience higher emotional sensitivity. Thus, the functional effect of regret may have remained until the final exam (or lasted longer than male students) for female students. The longitudinal nature of this research compared to research that utilizes a one-time measurement may be relevant in explaining the gender differences in our findings. The benefits derived from these negative experiences may occur over time for individuals with a better memory of this emotional information.

Another possible explanation for this gender difference is that women tend to place more value on effort than men do. For example, compared to men, women are less likely to create excuses for possible failure because women value putting forth effort whereas men value protecting ability beliefs [16]. Thus, after regret experiences, women may put more effort to find a way to improve future performance, but men may try more to protect ability beliefs and the self in the exchange for motivation decrements [e.g. 12]. These explanations for the current results should be examined in future research.

The current research identifies potential benefits derived from regret experiences for women. However, it is important to consider the possible costs associated with these regret experiences. In our earlier work [17] we have seen that women with similar course grades experience more regret than men, and it is worth investigating whether the success of women in these early

engineering courses comes at too high an emotional cost. Despite having functional consequences, in a nationally representative sample regret was also associated with negative mental health outcomes like anxiety and depression [18]. In this sample, women reported a greater likelihood of rumination on negative events and experiences of regret. Additionally, women in this study reported more distress and anxiety and lower positive affect than men. Consequently, the mental health costs associated with regret should be considered in conjunction with regret's effects on performance. Future research should investigate the impact of regret on retention in engineering for both men and women, because the functional consequences of improved course performance are not meaningful if regret experiences ultimately lead women to leave the program.

Although our findings suggest that women may react differently than men when experiencing regret, these analyses were exploratory and many questions still need to be answered. Future research should investigate if this finding is applicable to students outside of engineering. As the present study focuses on first-year students' academic success, conclusions made about gender differences in the functionality of regret more broadly should be approached with caution. Future research should examine if similar gender differences exist beyond this sample. Additionally, it is important to consider retention as an outcome measure beyond the current measure of course performance. The current research is limited by making interpretations based on a single semester. Despite regret's potentially positive impact on grades, greater emotional distress may have negative consequences on women's retention in engineering majors. If regret has a negative impact on retention, future intervention strategies could focus on managing the affective distress aroused by poor course performance. Future research should investigate the relationship between regret and retention.

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