Online Motivational Interventions: Improving Academic Achievement in Female STEM Students

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Background

To address continually decreasing enrollment and rising attrition in post-secondary STEM degree programs, particularly for women (AUCC, 2011; Cheryan, 2012; Engineers Canada, 2012), this study examined the longitudinal achievement benefits of web-based, motivational programs for female students in the natural sciences over a 1-year period.

Despite a lack of gender differences in mathematics and science aptitude (e.g., Ceci et al., 2009; Hyde et al., 2008; Waber et al., 2007), female's subjective perceptions of competence are lower in STEM domains as compared to males (e.g., Schunk & Pajares, 2005). From a motivational perspective, Weiner's (1985, 2006) attribution theory underscores the importance of perceptions of personal control in predicting student engagement and achievement, with over 30 years of research showing brief interventions encouraging personally controllable explanations (attributions) for academic setbacks to consistently improve academic motivation and performance (i.e., Attributional Retraining (AR); for reviews, see Forsterling, 1985; Haynes et al., 2009; Wilson et al., 2002).

However, despite considerable research on post-secondary students in social science programs, there exists remarkably few studies evaluating the longitudinal achievement effects of motivational interventions for female college students in STEM programs. Following from recent studies highlighting the benefits of computer-based AR for secondary school children on math performance (e.g., Germany: Dresel & Haugwitz, 2008), and web-based AR on college student achievement (Canada: Hall et al., 2005, 2013; US: Hubbard et al., 2012), the present study evaluated the utility of online AR programs for females in STEM disciplines for promoting long-term, objective achievement outcomes in higher education.

Method

Participants and procedures. The sample consisted of 52 female students enrolled in 1 of 6 STEM disciplines at the University of California, Irvine (physical sciences, biological sciences, health sciences, computer/information sciences, engineering, medicine). Participants were compensated with course credit or entered into a raffle for an Ipod. In the Winter '07 semester, participants were automatically assigned by the study website to the AR treatment or

Method (cont'd)

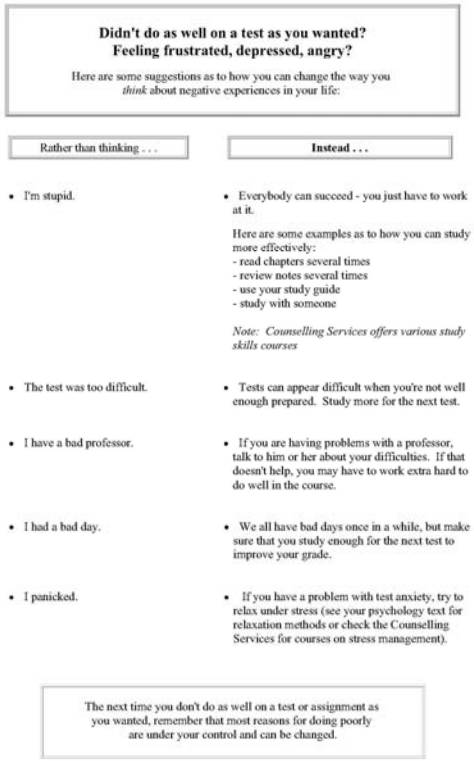
No AR control group based on the order at which they arrived at the preceding questionnaire (1 = No AR, 2 = Test AR, 3 = Writing AR, 4 = No AR, etc.). The time required to read and respond to the intervention content was ~20-30 minutes. Sessional GPAs for the Winter '07 and Fall '07 semesters were obtained from the UCI Registrar's Office for all participants.

Attributional retraining. In the first AR phase, participants first reviewed a brief, web-based reading (i.e., an informational schematic) based on an AR handout used in previous in-person AR studies (e.g., Perry & Struthers, 1994). The reading consisted of various statements informing them of the benefits of personally controllable attributions (e.g., effort: "I didn't study hard enough") as opposed to uncontrollable attributions (e.g., ability: "I'm not smart enough to succeed in this course") following poor performance. In the second phase, participants completed a timed aptitude test or writing assignment.

The *aptitude test* (Hall et al., 2004; Perry & Dickens, 1984) consisted of two sections including verbal analogy and mathematics questions (5 minutes per section). The test was intentionally difficult in order to elicit reactance and promote the use of the adaptive failure attributions. The *writing assignment* (cf., deep learning; Entwistle, 2000) required students to abstractly reflect on the AR information summarizing the content presented, listing potential reasons for poor performance in students, and providing examples of how they could incorporate the AR information into their studies (15 minutes). The writing/test exercise was followed by a debriefing page after which the AR reading was presented a final time for review.

Analysis & Results

A repeated-measures ANCOVA was conducted with the AR intervention (No AR, Test AR, Writing AR) and Time (Winter '07, Fall '07) as predictors of sessional GPA. Fall '06 GPA was included as a covariate to control for potential confounds due to prior achievement. Results showed a within-subjects interaction between Time and AR on students' GPA, $F(2,48) = 3.458$, $p = .040$. Immediate gains were observed for participants in the Aptitude Test AR condition by the end of the semester, however this improvement was no longer evident by the fall semester. In contrast, participants in the Writing AR condition did not show immediate gains in GPA, but did obtain higher GPAs by the fall semester.

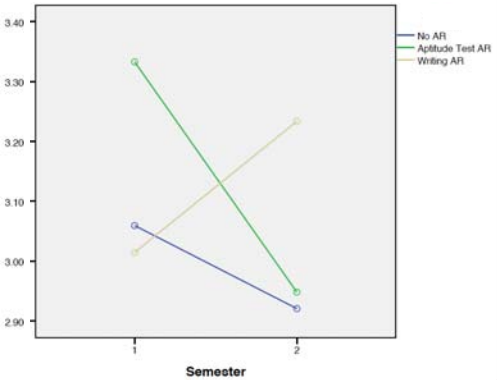


Didn't do as well on a test as you wanted?
Feeling frustrated, depressed, angry?

Here are some suggestions as to how you can change the way you *think* about negative experiences in your life:

Rather than thinking . . .	Instead . . .
• I'm stupid.	• Everybody can succeed - you just have to work at it. Here are some examples as to how you can study more effectively: - read chapters several times - review notes several times - use your study guide - study with someone *Note: Counselling Services offers various study skills courses*
• The test was too difficult.	• Tests can appear difficult when you're not well enough prepared. Study more for the next test.
• I have a bad professor.	• If you are having problems with a professor, talk to him or her about your difficulties. If that doesn't help, you may have to work extra hard to do well in the course.
• I had a bad day.	• We all have bad days once in a while, but make sure that you study enough for the next test to improve your grade.
• I panicked.	• If you have a problem with test anxiety, try to relax under stress (see your psychology text for relaxation methods or check the Counselling Services for courses on stress management).

The next time you don't do as well on a test or assignment as you wanted, remember that most reasons for doing poorly are under your control and can be changed.



Discussion

The present findings are consistent with recent research underscoring the benefits of web-based motivational interventions for improving achievement in college students in demonstrating significant, long-term benefits of online AR on sessional GPA over an academic year for females in STEM disciplines. The significant interaction effect observed further suggests that different intervention formats may realize their effectiveness at different times, with the more applied/direct AR format involving a mock failure experience (aptitude test) improving achievement within 3 months, and the abstract writing-based AR format having a longer-term benefit on GPA one year later.

Taken together with recent findings with junior college students in STEM disciplines showing self-efficacy to be a significant predictor of adjustment and persistence specifically for females (Simon et al., 2014), these results suggest that web-based programs may be effective in improving perceptions of competence, emotional well-being, and attrition in post-secondary female students in STEM programs. Further research is warranted to examine the utility of larger-scale, institutionally administered, web-based programs for facilitating adaptive motivational beliefs, with the benefits of these programs in the natural sciences expected primarily for female students.

References

AUCC (The Association of Universities and Colleges of Canada). (2011). *Trends in higher education: Volume 1 – Enrolment.* Ottawa, Canada: Author.

Ceci, S. J., & Williams, W. M. (2010). Sex differences in math-intensive fields. *Current Directions in Psychological Science, 19,* 275–279.

Cheryan, S. (2012). Understanding the paradox in math-related fields: Why do some gender gaps remain while others do not? *Sex Roles, 66,* 184–190.

Dresel, M., & Haugwitz, M. (2008). A computer-based approach to fostering motivation and self-regulated learning. *Journal of Experimental Education, 77,* 3–20.

Engineers Canada. (2012). *Canadian engineers for tomorrow: Trends in engineering enrolment and degrees awarded 2007-2011.* Ottawa: Author.

Entwistle, N. (2000). Approaches to studying and levels of understanding: The influences of teaching and assessment. In J. Smart (Ed.), *Higher education: Handbook of theory and research* (Vol. 15, pp. 156–218). New York, NY: Agathon Press.

Forsterling, F. (1985). Attributional retraining: A review. *Psychological Bulletin, 98,* 495-512.

Hall, N. C., Hladkyj, S., Perry, R. P., & Ruthig, J. C. (2004). The role of attributional retraining and elaborative learning in college students' academic development. *Journal of Social Psychology, 144,* 591-612.

Hall, N. C., Perry, R. P, Ruthig, J. C., Haynes, T. L., & Stupnisky, R. H. (2005, April). *Internet-based attributional retraining: Longitudinal effects on academic achievement in college students.* Paper presented at the American Educational Research Association Annual Meeting, Montreal, QC.

Hall, N. C., Stupnisky, R., Azevedo, R., & Rahimi, S. (2013, April). *Internet-based attributional retraining and self-esteem: Improving academic achievement in at-risk students through writing techniques.* American Educational Research Association, San Francisco, CA.

Haynes, T. L., Perry, R. P., Stupnisky, R. H., & Daniels, L. M. (2009). A review of attributional retraining treatments: Fostering engagement and persistence in vulnerable college students. In J. Smart (Ed.), *Higher education: Handbook of theory and research* (Vol. 24, pp. 227-272). The Netherlands: Springer.

Hubbard, K., Ringo, J., Hall, N. C., & Julio, L. (2012, June). *Investigating the impact of internet-based attributional retraining on high self-esteem university students.* Society for Teaching and Learning in Higher Education Annual Conference, Montreal, QC.

Hyde, J. S., Lindberg, S. M., Linn, M. C., Ellis, A., & Williams, C. (2008). Gender similarities characterize math performance. *Science, 321,* 494–495.

Perry, R. P., & Struthers, C. W. (1994, April). *Attributional retraining in the college classroom: Some causes for optimism.* Paper presented at the American Educational Research Association Annual Meeting, New Orleans, LA.

Perry, R. P., & Dickens, W. J. (1984). Perceived control in the college classroom: Response-outcome contingency training and instructor expressiveness effects on student achievement and causal attributions. *Journal of Educational Psychology, 76,* 966-981.

Schunk, D. H., & Pajares, F. (2005). Competence perceptions and academic functioning. In A. J. Elliot & C. S. Dweck (Eds.), *Handbook of competence and motivation* (pp. 85–104). New York, NY: The Guilford Press.

Simon, R. A., Aulls, M. W., Dedic, H., Hubbard, K. A., & Hall, N. C. (2014). *Exploring student persistence in STEM programs: A motivational model.* Manuscript submitted for publication.

Waber, D. P., De Moor, C., Forbes, P., Almli, C. R., Botteron, K. N., Leonard, G., et al. (2007). The NIH MRI study of normal brain development: Performance of a population based sample of healthy children aged 6 to 18 years on a neuropsychological battery. *Journal of the International Neuropsychological Society, 13,* 1-18.

Weiner, B. (1985). An attributional theory of achievement motivation and emotion. *Psychological Review, 92,* 548-573.

Weiner, B. (2006). *Social motivation, justice, and the moral emotions: An attributional approach.* Mahwah, NJ: Lawrence Erlbaum Associates.

Wilson, T. D., Damiani, M., & Shelton, N. (2002). Improving the academic performance of college students with brief attributional interventions. In J. Aronson (Ed.), *Improving academic achievement: Impact of psychological factors on education* (pp. 88-108). San Diego, CA: Academic Press.

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