

INVESTIGATING SELF-EFFICACY, TEST ANXIETY, AND PERFORMANCE IN COLLEGE ALGEBRA

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College Algebra students who struggle to pass the course could face delayed graduation or fail to obtain their degree. A key part to academic performance is self-regulated learning which includes self-efficacy and test anxiety as parts of motivation, as well as learning strategies. This study aims to investigate the change in motivation and learning strategies over the course of a semester and the relationship of this change to performance in College Algebra, as measured by final course grade. Test anxiety and self-efficacy were measured at the beginning and end of the semester using the Motivated Strategies for Learning Questionnaire. During the semester, self-efficacy decreased, and test anxiety increased. Moreover, the increase in test anxiety predicted performance. An important finding from the study was that the students who experience more stress on exams are the ones whose grades suffer the most.

Keywords: Affect, Emotion, Beliefs, and Attitudes; Post-Secondary Education

Introduction

A large number of students take College Algebra each year in the United States. Generally, College Algebra fulfills a graduation requirement for non-math intensive majors and has historically been structured to prepare students for calculus (Gordon, 2008). While required for many students, only about 50% of students earn an A, B, or C in the course (Ganter & Haver, 2011). This could result in a graduation delay or failure to obtain a degree. With so many students unable to pass College Algebra, research is needed to investigate what occurs over the course of a semester to impact student performance.

A key aspect of academic performance is self-regulated learning (Berger & Karabenick, 2011; Pintrich & De Groot, 1990; VanderStoep, Pintrich, & Fagerlin, 1996). Students who are self-regulated learners utilize cognitive and metacognitive strategies to be successful in their learning. However, the knowledge of strategies is not enough; a student must also have the motivation to use them (Pintrich & De Groot, 1990; VanderStoep et al., 1996). Therefore, both motivation and learning strategies could be crucial to improving achievement in College Algebra.

This study aims to investigate the self-regulated learning of College Algebra students and answer the following research questions:

- What are the changes in College Algebra students' motivation and learning strategies over the course of a semester? And are the changes the same for all students?
- What is the relationship between the changes in motivation and learning strategies and performance in College Algebra?

While motivation and learning strategies are both important components of self-regulated learning, this paper focuses on two motivation components: self-efficacy and test anxiety. This controlled focus is due to test anxiety being a significant finding for both research questions, and self-efficacy is prevalent in the literature.

Literature Review

Over the last few decades, self-efficacy and test anxiety have been studied extensively. Self-efficacy is a key component in social cognitive theory and refers to “beliefs in one’s capabilities to organize and execute the courses of action required to produce given attainments” (Bandura, 1997). Test anxiety is a multi-dimensional construct defined by Zeidner (1998) as “the set of phenomenological, physiological, and behavioral responses that accompany concern about possible negative consequences or failure on an exam or similar evaluative situation” (p. 17).

At the college level, many studies have examined how self-efficacy or test anxiety change over time but with mixed results. For two online courses, no statistically significant changes in self-efficacy (Hodges & Kim, 2010) and test anxiety (Chapman, 2013) were detected during the semester. Others found decreases in self-efficacy (DiBenedetto & Bembenuddy, 2013) and test anxiety (Fournier, Couret, Ramsay, & Caulkins, 2017) in science courses. Some reported increases in self-efficacy in biology (Ainscough et al., 2016) and test anxiety for medical students (Kim & Jang, 2015) over the course of a semester.

Self-efficacy and test anxiety have also been studied in relation to academic performance at the college-level. Several studies found self-efficacy (Hodges & Kim, 2010; Roick & Ringeisen, 2018) and test anxiety (Gibbens, 2019; Hieb, Lyle, Ralston, & Chariker, 2015) to be statistically significant predictors of performance. However, these studies measured self-efficacy and test anxiety at a single time point, and change over time was not used as a predictor of performance.

Only two studies were found to look at change over time as a predictor of performance. Fournier et al. (2017) found a decrease in test anxiety was not a statistically significant predictor of performance, and DiBenedetto and Bembenuddy (2013) found that the decrease in self-efficacy was negatively correlated with final course grade. In light of these mixed results and other studies, this paper sought to examine the change in self-efficacy and test anxiety for College Algebra students over the course of a semester, and if the observed changes impact the final course grade.

Methodology

This study was conducted at a public university in the northeast region of the United States. During the spring semester of 2017, six sections of College Algebra were included in the study with 166 out of 227 students (73%) consenting to participate. To measure the changes in students’ motivation and learning strategies, the Motivated Strategies for Learning Questionnaire (MSLQ) was used; an instrument considered to be both valid and reliable for this population of undergraduate students (Duncan & McKeachie, 2005). The MSLQ consists of two sections, motivation and learning strategies, with 15 scales total. These scales can be used together or individually for a total of 81 survey items, each with a Likert-scale from 1 to 7.

The students were asked to complete the MSLQ during the third week of the semester (T_1) and again on the last day of classes (T_2). Students’ final course grade was also collected. Changes in all 15 MSLQ scales were considered by final course grades using a MANOVA with the paired differences ($T_1 - T_2$) as a response variable and final letter grade as the factor. In order to investigate how these changes in motivation and learning strategies relate to the students’ final course grade, multiple linear regression was performed using changes in MSLQ scales over time and final numerical course grade. Statistical analysis was conducted using the R software package. Familywise false coverage probabilities and error rates were controlled using an adjustment based on the multivariate t -distribution that is implemented in the emmeans (Lenth, 2019) and glht (Hothorn, Bretz, & Westfall, 2008) R packages.

Results

The MANOVA results indicate that final letter grade in College Algebra is statistically significant (Pillai Test Statistic = .888 and p -value < .0001). Post-hoc comparisons using a 95% familywise confidence level indicate that students who earn a final course grade of “D” or “F” are the only ones to experience statistically significant changes in the MSLQ scales. Students who earn a “D” in College Algebra on-average experience a decline in self-efficacy between 0.59 and 1.79 points. Students who earn an “F” in College Algebra experience a decrease in self-efficacy between 0.78 and 2.07 points on-average, and an increase in test anxiety by 0.67 and 2.25 points on-average. When controlling for familywise error rate, multiple linear regression analysis showed that test anxiety is the only statistically significant predictor of final course grade at the 5% significance level. For students that experienced a one-point increase in test anxiety during the semester, it is expected their mean final course grade in College Algebra will decrease by between 0.21 and 6.81 percentage points.

Discussion

The present paper examined the changes in motivation and learning strategies for College Algebra students over the course of a semester, and if the observed changes impacted the final course grade. During the semester, self-efficacy decreased while test anxiety increased; findings that are consistent existing research (DiBenedetto & Bembenuddy, 2013; Kim & Jang, 2015). However, not all students experienced these changes. Students who earned a “D” or an “F” in College Algebra felt less capable of being successful in the course as the semester went on, similar to findings by VanderStoep et al. (1996). Additionally, the students who earned an “F” experienced increased worry and had a preoccupation with performance over the course of the semester, consistent with Fournier et al. (2017). This is an interesting result as the students who need the most support were the ones to experience negative changes in their motivation during a semester of College Algebra.

For this study, there was a relationship between the changes in motivation and learning strategies and performance for College Algebra students. As a semester goes on, the students who experience more and more stress on exams are the ones whose grades suffer the most. This is in contrast to work by Fournier et al. (2017) and DiBenedetto and Bembenuddy (2013). Paired with the other results, students who end up earning an “F” in course experience increases levels of test anxiety along with decreased self-efficacy; this increase in test anxiety has a direct, negative effect on their course grade.

While there is ample research on both self-efficacy and test anxiety, the findings are not always consistent and vary from subject to subject. This highlights a need for continuing research on both motivation components. To improve the passing rates of College Algebra, additional research is needed to investigate how to improve self-efficacy and decrease test anxiety, especially for the students likely to earn a non-passing grade. With the key finding that test anxiety increases over the semester and significantly predicts performance, future studies could attempt interventions throughout the semester to curb anxiety.

References

- Ainscough, L., Foulis, E., Colthorpe, K., Zimbardi, K., Robertson-Dean, M., Chunduri, P., & Lluka, L. (2016). Changes in biology self-efficacy during a first-year university course. *CBE—Life Sciences Education, 15*(2), ar19.
- Bandura, A. (1997). *Self-efficacy: The exercise of control*. Macmillan.
- Berger, J.L. & Karabenick, S.A. (2011). Motivation and students’ use of learning strategies: Evidence of unidirectional effects in mathematics classrooms. *Learning and Instruction, 21*(3), 416-428. DOI: 10.1016/j.learninstruc.2010.06.002
- Chapman, D. L. (2013). *Multimedia instructional tools and student learning in computer applications courses*. (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database. (UMI No. 1461743173).

- DiBenedetto, M. K., & Bembenutty, H. (2013). Within the pipeline: Self-regulated learning, self-efficacy, and socialization among college students in science courses. *Learning and Individual Differences, 23*, 218-224.
- Duncan, T.G. & McKeachie, W.J. (2005) The making of the Motivated Strategies for Learning Questionnaire. *Educational Psychologist, 40*(2), 117-128. DOI: 10.1207/s15326985ep4002_6.
- Fournier, K.A., Couret, J., Ramsay, J.B., & Caulkins, J.L. (2017). Using collaborative two-stage examinations to address test anxiety in a large enrollment gateway course. *Anatomical Sciences Education, 10*(5), 409-422.
- Ganter, S. & Haver, W. (Eds, 2011). Partner Discipline Recommendations for Introductory College Mathematics and the Implications for College Algebra. Washington, DC: Mathematical Association of America.
- Gibbens, B. (2019). Measuring Student Motivation in an Introductory Biology Class. *The American Biology Teacher, 81*(1), 20-26.
- Gordon, S. P. (2008). What's wrong with College Algebra? *PRIMUS, 18*(6), 516-541.
- Hieb, J. L., Lyle, K. B., Ralston, P. A., & Chariker, J. (2015). Predicting performance in a first engineering calculus course: Implications for interventions. *International Journal of Mathematical Education in Science and Technology, 46*(1), 40-55.
- Hodges, C. B., & Kim, C. (2010). Email, self-regulation, self-efficacy, and achievement in a college online mathematics course. *Journal of Educational Computing Research, 43*(2), 207-223.
- Hothorn, T., Bretz, F., & Westfall, P. (2008). Simultaneous inference in general parametric models. *Biometrical Journal, 50*(3), 346-363.
- Kim, K. J., & Jang, H. W. (2015). Changes in medical students' motivation and self-regulated learning: a preliminary study. *International Journal of Medical Education, 6*, 213.
- Lenth, R. (2019). emmeans: Estimated marginal means, aka least-squares means. R package version 1.4.
- Pintrich, P.R. & De Groot, E.V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology, 82*(1), 33-40.
- R Core Team (2019). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Retrieved from <https://www.R-project.org/>
- Roick, J., & Ringeisen, T. (2018). Students' math performance in higher education: Examining the role of self-regulated learning and self-efficacy. *Learning and Individual Differences, 65*, 148-158.
- Vanderstoep, S.W., Pintrich, P.R., & Fagerlin, A. (1996). Disciplinary differences in self-regulated learning in college students. *Contemporary Educational Psychology, 21*(4), 345-362.
- Zeidner, M. (2010). Test anxiety. *The Corsini Encyclopedia of Psychology, 1-3*.