SELF-EFFICACY AND FIRST YEAR BIOLOGY MAJORS

Authors: Michele J. Mann and Christopher Golubski The University of Texas at Austin

Abstract

Using the Motivated Strategies for Learning Questionnaire (MSLQ), self-efficacy was evaluated at the beginning and end of the semester in an entry-level biology course for biology majors. There was a significant difference in self-efficacy from the pretest to the posttest on two questions. The students' self-efficacy significantly decreased on questions "I expect to do well in this biology class" ($p = .06$) and "Considering the difficulty of this biology course, the teacher, and my skills, I think I will do well in this class" ($p = .033$). Moreover, even though the differences in the other six questions were not significant, they showed a downward trend between the beginning of the course and the end of the course in regard to student self-efficacy. We found a statistically significant difference in biology course grade and overall semester GPA, $t(70) = -1.77$, $p = .082$, indicating that overall GPA was higher than the students' grade in their biology course. It appears that students have an inflated perception of their skill level in college level STEM classes. Helping students develop metacognitive skills might help them transition from a high school setting to a competitive college environment will help retain valuable students in STEM majors.

Introduction

Science, technology, math, and engineering are embedded in our modern world and hold many answers to the world's most pressing challenges (National Research Council, 2012), yet our collegiate education system is not creating students with a strong background in science, technology, engineering, and mathematics (STEM) fields. Recent data on biology from the College Senior Survey (CSS), which is administered by the Cooperative Institutional Research Program (CIRP) with 20,747 2012 graduates, found that 51% of the students that started with a biology major switched out of biology before they graduated (Higher Education Research Institue at UCLA, 2013). Students that are successful or perceived themselves to be successful are more satisfied with college and are more likely to remain in their major (Chemers, Hu, & Garcia, 2001). Students are not very likely to switch into a STEM degree after they start college, which makes it important that the students who matriculate in biology graduate with the degree.

Conceptual Framework

This paper uses Bandura's social cognitive theory (1986) to examine first-year biology majors' self-efficacy during their first biology course. Social cognitive theory views people as self-reflecting, self-organizing, self-regulating, and proactive, not just reacting to environmental forces or driven by inner impulses (Bandura, 1986). Self-efficacy is when an individual thinks they are capable of performing tasks necessary to achieve their goals (Bandura, Barbaranelli, Caprara, & Pastorelli, 1996). Self-efficacy has been linked to academic success, students' decisions, effort students' put into tasks, and student stress (Chemers et al., 2001; Pajares & Schunk, 2001; Solberg & Viliarreal, 1997; Vuong, Brown-Welty, & Tracz, 2010).

Literature Review

For the United States to continue to compete in the area of science and technology we need one million more STEM professionals over the next decade, which means that we need to increase the number of STEM graduates by 34% over our current annual rate (Presidents'

Advisory Council on Science and Technology, 2012). Only 40% of the students who start in a STEM college degree program complete a degree in any STEM field (Presidents' Advisory Council on Science and Technology, 2012). If students have high self-efficacy they are more likely to view a STEM degree as a challenge to transcend rather than a threat to escape (Pajares & Schunk, 2001). Self-efficacy has two major elements: efficacy expectation, an individual's belief about whether he or she can perform a task and response outcome expectancy, an individual's belief that the action performed will result in a desired outcome (Haney et al., 2011). Students' general adjustment to college and college academic areas and self-efficacy have all been examined, but there has not been specific examination of biology majors' self efficacy during their first semester. (Chemers et al., 2001; Haney et al., 2011; Hutchison, Follman, Sumpter, & Bodner, 2006; Lent, Brown, & Larkin, 1984; Multon, Brown, & Lent, 1991; Solberg & Viliarreal, 1997; Vuong et al., 2010). As students age, their self-efficacy becomes more specific and influential which makes college students greatly affected by their level of self-efficacy (Bong, 2001).

Understanding how the students' environment can influence their self-efficacy can help others learn how to mediate these effects (Bandura et al., 1996). The students' beliefs and aspirations, in turn, contribute to their academic achievement both directly and by fostering peer acceptance and reducing depression and problem behavior that can undermine productive engagement in academic pursuits (Bandura et al., 1996, p. 1207). Students can build self-efficacy by having successful experiences, observing a peer's success at a task, and having a credible conversation with someone the student respects (Margolis & Mccabe, 2006). As STEM educators, we need to be aware of these opportunities that can build a student's self-efficacy opportunities such as increasing opportunities for proximal goals, verbally encouraging students to set their own goals, and providing frequent and immediate feedback (Pajares & Schunk, 2001). Student perception of their achievement has more to do with their self-efficacy than their actual grades. In the case of STEM majors, they might actually change majors because they do not perceive that they are successful when they actually have good grades (Bandura et al., 1996). Knowing how self-efficacy effects students majoring in STEM fields and how to build strong self-efficacy in students can improve retention in the STEM majors.

Research Design

We studied freshmen biology majors at a large, competitive, four-year public university in the south. The students are of diverse ethnicities and gender all enrolled in the biology major course during their first fall term. All the students took the Motivated Strategies for Learning Questionnaire (MSLQ) at the beginning and end of the semester. The MSLQ uses a 7 point Likert Scale where 7 is the highest and 1 is the lowest. We specifically examined self-efficacy questions, which have a robust reliability with a Cronbach's alpha score of .93 (Artino Jr, 2005). Our research question is does self-efficacy change for biology majors during their first biology course.

Findings

We performed a quantitative analysis of the pre and post course MSLQ survey responses. The survey asked the same questions each time about the students' self-efficacy in relation to their course performance. Not all differences in survey responses from the beginning of the course to the end of the course were statistically significant; however, we did find some interesting trends that should be noted due to small sample size. One of the greatest limitations

of our analysis is our low sample size. Only 71 (approximately 20%) of the cohort completed both the pre and post test survey questions, so we were only able to complete a marginally effective analysis. We expect this work to continue to evolve as we gather more data from future students who complete this program. As of the time of publication and presentation (late Fall 2013), we have four times the data under which this analysis was performed. Additionally, we chose to list non-significant results for two reasons. First of all, the trend in all of these questions lends credibility to our hypothesis of decreasing self-efficacy. Secondly, we strongly believe that our results would have been significant if we had a greater participation rate and sample size. We believe, based on the significance of the results we did receive, that the underlying question of decreased self-efficacy holds, based on not only the survey data, but also the grade data at the end of the semester.

The following table illustrates significant items (at $\alpha = .10$):

Question	**Mean Pretest**	**Mean Posttest**	**T, df = 17**	**p-value**
"I expect to do well in this biology class."	6.28	5.44	2.012	.06
"Considering the difficulty of this biology course, the teacher, and my skills, I think I will do well in this class."	6.17	5.22	2.315	.033

Non-significant results

Question	**Mean Pretest**	**Mean Posttest**
"I believe I will receive an excellent grade in this biology class."	5.89	5.17
"I am certain I can understand the most difficult material presented in the readings for this biology course."	5.65	5.65
"I am confident that I can understand the basic concepts taught in this biology course."	6.50	6.17
"I am certain I can master the skills being taught in this biology course."	6.22	5.67
"I am confident I can do an excellent job on the assignments and tests in	5.89	5.39

this biology course."		
"I am confident that I can understand the most complex material presented by the instructor of this biology course."	5.83	5.50

The results indicate that students had a higher self-efficacy at the beginning of the course than at the end of the course. Moreover, even though the differences in the other six questions were not significant, they showed a downward trend between the beginning of the course and the end of the course in regard to student self-efficacy. Additionally, we found a statistically significant difference in biology course grade and overall semester GPA, $t(70) = -1.77$, $p = .082$, indicating that overall GPA was higher than the students' grade in their biology course.

Conclusions

We believe that one of the primary reasons that self-efficacy decreases from the beginning to the end of the course is that students often have inflated perceptions of their skill levels in STEM courses. Pajares and Kranzler (1995) found that high school students were overconfident of their mathematical problem solving ability but students in higher math levels were more accurate. This effect is likely compounded by the fact that these students took this course in the first term of their freshman year in college and will develop more realistic self-efficacy. Hence, many of the students have likely not sufficiently adjusted to the rigor of college STEM courses, especially at a competitive university. These results suggest that entry-level STEM courses need to be aware of the students' over-confident self-efficacy and possibly implement an early intervention system to ensure that students are both aware and capable of surmounting rigorous standards.

The average grade in this course was 3.27, which is roughly equivalent to a B. Most freshmen entering this particular university are in the top group of their high school classes; therefore, they are likely accustomed to earning A grades up until this point. The fact that the average student earns a B in this course is a potential explanation as to why students' self-efficacy decreased as the semester progressed.

Implications

Self-efficacy plays an important role in students' academic successes (Bandura, 1986). However, there are elements affecting student's self-efficacy in their first term biology course. Pajares and Kranzler (1995) discouraged any efforts to ever lower students' self-efficacy. The solution could potentially be helping students improve their metacognitive processes so that they properly prepare for the course without lowering their self-efficacy (Pajares & Kranzler, 1995). Helping students transition from a high school setting to a competitive environment of college will help retain valuable students in the STEM majors. Increases in self-efficacy may significantly reduce attrition rates in these programs.

This study raises important questions that need additional research. We will continue to follow this cohort to monitor their progress, as well as acquire additional data on first semester freshmen through new cohorts as they enter the university. In following the students from this study, we will investigate changes in self-efficacy as time progresses as well as student attitudes toward their course performance in more advanced courses. This data will likely give us insight as to why the attrition rate for biology majors is considerably higher than majors in the

humanities.

References

Artino Jr, A. R. (2005). Review of the Motivated Strategies for Learning Questionnaire. *Online Submission*.

Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory.

Bandura, A., Barbaranelli, C., Caprara, G. V., & Pastorelli, C. (1996). Multifaceted Impact of Self-Efficacy Beliefs on Academic Functioning. *Child Development, 67*(3), 1206-1222. doi: 10.2307/1131888

Bong, M. (2001). Between- and within-domain relations of academic motivation among middle and high school students: Self-efficacy, task value, and achievement goals. *Journal of Educational Psychology, 93*(1), 23-34. doi: 10.1037/0022-0663.93.1.23

Chemers, M. M., Hu, L.-t., & Garcia, B. F. (2001). Academic self-efficacy and first year college student performance and adjustment. *Journal of Educational Psychology, 93*(1), 55-64. doi: 10.1037/0022-0663.93.1.55

Haney, J. J., Midden, W. R., Nurnberger-Haag, J. A., Partin, M. L., Scheuermann, A., Underwood, E. M., & Worch, E. A. (2011). Yes I can: the contributions of motivation and attitudes on course performance among biology nonmajors. [Report]. *Journal of College Science Teaching, 40*(6), 86.

Higher Education Research Institute at UCLA. (2013). Class of 2012: Findings from the College Senior Survey (pp. 4). University of California, Los Angeles: Cooperative Institutional Research Program (CIRP).

Hutchison, M. A., Follman, D. K., Sumpter, M., & Bodner, G. M. (2006). Factors Influencing the Self‐Efficacy Beliefs of First‐Year Engineering Students. *Journal of Engineering Education, 95*(1), 39-47.

Lent, R. W., Brown, S. D., & Larkin, K. C. (1984). Relation of self-efficacy expectations to academic achievement and persistence. *Journal of Counseling Psychology, 31*(3), 356.

Margolis, H., & Mccabe, P. P. (2006). Improving Self-Efficacy and Motivation: What to Do, What to Say. *Intervention in School and Clinic, 41*(4), 218-227. doi: 10.1177/10534512060410040401

Multon, K. D., Brown, S. D., & Lent, R. W. (1991). Relation of self-efficacy beliefs to academic outcomes: A meta-analytic investigation. *Journal of Counseling Psychology, 38*(1), 30-38. doi: 10.1037/0022-0167.38.1.30

National Research Council. (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*: The National Academies Press.

Pajares, F., & Kranzler, J. (1995). Self-efficacy beliefs and general mental ability in mathematical problem-solving. *Contemporary Educational Psychology, 20*(4), 426-443.

Pajares, F., & Schunk, D. H. (2001). Self-beliefs and school success: Self-efficacy, self-concept and school achievement In R. Riding & S. Rayner (Eds.), *Perception* (pp. 239-266). London: Ablex Publishing.

Presidents' Advisory Council on Science and Technology. (2012). Engage to excel: Producing one million additional college graduates with degrees in science, technology, engineering, and mathematics (pp. 1-130).

Solberg, V. S., & Viliarreal, P. (1997). Examination of self-efficacy, social support, and stress as predictors of psychological and physical distress among Hispanic college students. *Hispanic Journal of Behavioral Sciences, 19*(2), 182-201.

Vuong, M., Brown-Welty, S., & Tracz, S. (2010). The effects of self-efficacy on academic success of first-generation college sophomore students. *Journal of College Student Development, 51*(1), 50-64.