Developing Self-regulation and Self-efficacy: A Cognitive Mechanism Behind the Success of Biology Boot Camps

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Abstract

The Louisiana State University Biology Intensive Orientation for Students (BIOS) Program has been found to be an effective retention initiative for freshman Biological Science majors (S. M. Wischusen, Wischusen, & Pomarico, 2010; S. M. Wischusen, Wischusen, W. E., 2007). Students who attended the five-day camp out-perform their non-participant peers in introductory biology courses and have higher retention, progression and graduation rates. This study uses a cognitive view to explore the underlying factors, self-regulation and self-efficacy, namely that contribute to the program's capacity to help students obtain sustainable academic success. The pre/post-test measurements of the Motivated Strategies for Learning Questionnaire, as well as qualitative measures, were employed to evaluate the program as a format for developing self-regulation and self-efficacy. BIOS was also shown to calibrate students' self-efficacy and self-regulation for optimal performance in Biology 1201, the introductory course for science majors. Camp participants exhibited higher self-efficacy, self-regulation, and final Biology 1201 grades than their non-BIOS peers. These results offer insight into the mechanism behind the success of science boot camps and the role of motivation and metacognition in STEM retention initiatives.

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Introduction

White House science and technology policy advisors have estimated that the US needs 1 million STEM professionals to solidify its lead in the global science and technology race (White House Office of Science and Technology, 2012). In order to meet this goal, at least 50% of students entering post-secondary Science, Technology, Engineering and Mathematics (STEM) must attain degrees. This is a difficult feat when considering an average of 30% of students leave STEM within the first two years of entering college (Seymour & Hewitt, 2000). Early departure from STEM majors has been attributed to both the nature of STEM instruction and the nature of college freshmen (Philip Jensen, Moore, R, 2008; P Jensen, Moore, R, 2008; P. Jensen, Moore, R, 2009a, 2009b; Moore, 2004; Seymour, 2002; Seymour & Hewitt, 2000).

A significant portion of STEM post-secondary education reform is the innovation of traditional, teacher-centered instructional methods to promote meaningful learning and student engagement (White House Office of Science and Technology, 2012). As more faculty implement metacognition, constructivism, active and inquiry learning techniques to transition to a student-centered classroom, students will have an increased responsibility in learning (Seymour, 2002). However, a majority of first-year STEM majors are unprepared to handle the innate challenges of STEM courses, not to mention the additional learning responsibilities.

To initiate the development of successful STEM majors, some STEM departments have created academic interventions, such as one-credit seminars, orientation programs, and bridge programs, to directly address the needs of STEM majors (S. Belzer, Miller, & Shoemake, 2003; Bonner, 2009; Chevalier, Chrisman, & Kelsey, 2001; Hutchison, Follman, Sumpter, & Bodner, 2006; Hutchison-Green, Follman, & Bodner, 2008; Minchella, Yazvac, Fodrea, & Ball, 2002; Reyes, Anderson-Rowland, & McCartney, 1998). Louisiana State University's Department of Biological Sciences created a unique intervention to address attrition in introductory biology that is caused by the unawareness and unpreparedness of biological science majors (S. M. Wischusen, Wischusen, & Pomarico, 2010; S. M. Wischusen, Wischusen, W. E., 2007). The Biology Intensive Orientation for Students (BIOS) program gives students a preview of introductory biology material and exams before the start of the fall semester. During the 5-day camp, students interact in a learning community of peers, mentors, and faculty while also receiving valuable information on learning strategies, undergraduate research, and academic policies.

Since the 2005 pilot, BIOS has shown to be an effective retention initiative as participants have higher averages on course exams and final course grades in introductory biology than non-participants (Wischusen, Wischusen, & Pomarico, 2010; Wischusen & Wischusen, 2007). BIOS students also outperform their peers in succeeding courses in the introductory sequence. Data show that participants have a significantly higher retention rate than non-participants. The BIOS model has not only shown to be effective, but also financially and human resource efficient. These characteristics have made BIOS practical for adoption by other college science departments across the nation.

While the grade and retention data for BIOS participants is substantial, the BIOS structure permits evaluation in additional ways. Because program administrators heavily integrated metacognitive principles into the design, measuring the effects of metacognition is an exceptional way to capture the cognitive and behavioral changes of the camp participants. While there are several areas of metacognition that are able to be evaluated, self-efficacy and self-regulation were chosen because these constructs parallel themes of attrition-related student behaviors in STEM education research of overconfidence and academic discipline.

Self-regulation and self-efficacy are two constructs that fall under the umbrella of metacognition and explain student behaviors and thinking. Self-regulated learning is recognized as the learning that takes place when an individual is a metacognitively, motivationally, and behaviorally active participant in his or her own learning (Zimmerman, 1989; Zimmerman & Pons, 1986). A self-regulated student is a goal setter who is able to seek help, manage time, self-evaluate, modify their environment, and strategize in order to achieve goals. Self-regulation has been shown to predict course performance, admissions status, and achievement levels (Kesici & Erdogan, 2009; Kitsantas, 2002; Kitsantas, Winsler, & Huie, 2008; Lee, Lim, & Grabowski, 2010; Ley, 1998; Ross, Green, Salisbury-Glennon, & Tollefson, 2006; Ruban & Reis, 2006; Schapiro & Livingston, 2000; Zimmerman, 2008).

Self-efficacy is recognized as a person's belief in their ability to accomplish a specific task. A person with strong self-efficacy views challenges as conquerable with effort and time, is more likely to self-regulate, and attributes failure to lack of effort. On the other hand, a person with weak self-efficacy views challenges as an impossible to overcome, quits in the wake of failure, attributes failure to luck or ability and is less motivated to become self-regulated. Individuals can overestimate their self-efficacy when judging the difficulty of a task and become overconfident. Inaccuracies in estimating self-efficacy can stem from success easily obtained in experiences. Success that is effortlessly obtained undermines peoples' need for perseverance, therefore weakening self-regulation (A. Bandura, 1997; Albert Bandura, Barbaranelli, Caprara, & Pastorelli, 1996; Usher & Pajares, 2008). Research has shown that self-efficacy is the best predictor of college success within the first year (Devonport & Lane, 2006; Kitsantas et al., 2008; Klassen, Krawchuk, & Rajani, 2008; Klomegah, 2007; Museus & Hendel, 2005; Ramos-Sánchez & Nichols, 2007; Zajacova, Lynch, & Espenshade, 2005). Self-efficacy is also indicative of students' tendencies to withdraw from introductory courses (Devonport & Lane, 2006).

Although not referenced specifically, themes of self-efficacy and self-regulation are found in STEM retention literature. In documenting the historical switch from STEM majors to non-STEM majors, Seymour and Hewitt (2000), discovered that negative experiences in introductory STEM courses decreased students' self-confidence in learning. Self-confidence and self-efficacy, as well as self-esteem, are part of a global construct of self-concept (Schunk, 1991). However, self-confidence and self-efficacy are the most closely related, as their levels vary by context and are competency dependent (Schunk, 1991). What makes self-efficacy most significant is that it is more specific to a task. For example, self-confidence relates to a student's perception of their chemistry abilities, while self-efficacy relates to individual abilities to accomplish more specific tasks like balancing reactions and drawing chemical structures. The task specific nature of self-efficacy permits a more adequate evaluation and prediction of academic behaviors than measures of confidence.

STEM literature has also documented a link between self-confidence and academic discipline. This relationship parallels that of self-efficacy and self-regulation. Social cognitive research suggests that high self-efficacy is often counterproductive to succeeding at any given task (Bandura, 2010). Highly efficacious individuals do not exert effort or utilize external resources as they feel that their abilities alone are adequate to complete the task. Moderate self-efficacy is optimal, as lower self-efficacy prompts the internal desire to pursue resources and input more effort to meet or exceed standards. Likewise, STEM researchers found that students in introductory science classes who are unsuccessful tend to have been overconfident at the beginning (Philip Jensen, Moore, R, 2008; P. M. R. Jensen, 2008, 2009a, 2009b). As a result, these students overestimate their grades, become lax, and adopt unsound academic behaviors, such as missing class and disregarding help sessions. On the other hand, students who are successful in introductory science classes are likely to be less confident and underestimate their grades. In order to compensate for their lack of confidence, students adopt sound academic practices. Overall, first-year students are unable to accurately perceive the challenge of introductory science courses simply because they have not been exposed to the type of learning expected from college faculty. Using only their strategies and experience in high school science courses, they are not prepared to handle the rigor of introductory science classes.

A substantial amount of STEM attrition is related to students' behaviors and perceptions. Therefore, STEM retention research and initiatives should involve activities that cultivate healthy levels of self-efficacy and strengthen self-regulation. These theories not only aid in addressing student thinking and actions, but also outline a learning process that is apparent, discernible, and inclined to be developed. The nature of self-regulated learning and self-efficacy has allowed researchers and practitioners to correlate student behaviors with academic performance. Validating the relationship among student behaviors, grades, and the impact of BIOS is a significant step in promoting the program as an effective format to combat STEM attrition. The purpose of this study is to assess the effect of a biology boot camp on the self-efficacy and self-regulation of freshman biology majors.

This study addresses the following questions:

1. What is the effect of a biology intensive orientation program on biology majors' self-efficacy and self-regulation?
2. How much of a student's academic performance in introductory biology do self-regulation and self-efficacy predict?

Methods

This quantitative study utilized 577 freshman students who attended a biology intensive orientation at Louisiana State University during the falls of 2010 and 2011. Approximately 62% (N=357) of samples were female and 38% male (N=220). The gender ratio is similar to what is found in a typical Biology 1201 course. The average ACT score was 26.96 and high school GPA was 3.54 for all BIOS participants. The average ACT score was 25.40 and high school GPA was 3.4 for 2010 and 2011. A small portion of the sample was first generation college students (20%). Minority students made up about 10%-15% of the BIOS participants. Minority participation was similar to the university's minority population. All students utilized in this sample have declared a major (biology, biochemistry, or microbiology) within the department of biological sciences.

The demographics of the control group were statistically insignificant from the BIOS cohort. Similar high school GPAs, ACT/SAT scores, as well as gender and ethnic breakdowns, were reported for each group. Not only were demographics of the control group similar, but also their levels of motivation. Student motivation must be considered any time a voluntary program is assessed. The BIOS researchers used a second control group during the first two years of the program (2005 and 2006) to address this issue. For these first two pilot years, more students registered to participate in BIOS than the program staff could accommodate. These students had been motivated enough to sign up, but did not participate in the camp. Therefore, in the assessment of each of the two cohorts, Wischusen and Wischusen (2007) used the waitlisted group as a second control group. In comparisons with the BIOS students and the original academically-matched control group, the waitlist performed identically to the control group and significantly lower than the BIOS students.

Orientation Structure

Participants were recruited during the spring and summer freshman orientation programs. Camp participation was voluntary. As BIOS is self-funded, the participation fee was $450, plus $125 for optional on-campus housing. Students who were deemed to have financial need (as decided by the LSU Student Aid and Scholarship office) were offered a $350 scholarship and free housing. This lowered the cost of the boot camp to $100, and since the program fees entitled the participating student a copy of the biology textbook ($250 value) and a "clicker" ($40), the student actually came out financially ahead in the camp.

The camp was set one week prior to the start of the fall semester to help students transition into college life and to help them retain the information they have received during the program. Students attended nine lectures taught by biological sciences faculty and nine informational sessions presented by university staff. They also took three exams, and participated in numerous study sessions. Lectures consisted of the same lecture material students encountered their first week in their introductory biology course. The student discussion topics included learning strategies, university policies and procedures, money management, and personal health. After each exam, instructors gave detailed feedback. This feedback included reasons for structuring questions, hints to answering questions, and the percentage students that chose each answer choice. Study sessions aimed to enable students to review lecture material and to obtain advice about succeeding as a science major. Participants were divided into small groups to promote peer-to-peer interactions in the study sessions. While students used their breakfast and lunch breaks to study and socialize, nightly dinners featured presentations on laboratory research from several university science professors and graduate students. After dinner, participants took tours of selected laboratories to gain better ideas of possible scientific research interest.

Students were organized into groups to cultivate various sizes of learning communities. The largest organized group in the orientation was recognized as a domain. Students who were enrolled in the same introductory biology section for the fall semester were organized into one domain. Therefore, participants were grouped with their potential classmates and, most of the time, their scheduled instructor. Students in each domain attended all BIOS lectures together. Domains contained an average of 100 students, depending on the total number of students participating in BIOS. The three domains were denoted by the colors purple, green, and gold and were further separated into smaller groups recognized as pods. Denoted by numbers, pods were groups of approximately 30 students. Students in each pod attended each study session together and sat together during nightly dinner and research presentations. One undergraduate student, who was a former BIOS participant, and one graduate science student led each pod.

Quantitative Data Collection and Procedure

The Motivated Strategies for Learning Questionnaire (MSLQ) was the main assessment tool of self-regulation and self-efficacy in this study. The MSLQ was designed using the social cognitive view (Duncan & McKeachie, 2005; Muis, Winne, & Jamieson-Noel, 2002; Pintrich, 1991). This perspective does not view motivation and use of learning strategies as characteristics of a learner but rather as skills fostered in a variety of contexts. Therefore, it was designed to focus on motivation and learning in a particular instance, context, or course. It incorporated the works of Zimmerman's self-regulated learning perspective because of its emphasis on motivation and learning in the classroom (Duncan & McKeachie, 2005; Zimmerman, 2002). The MSLQ is an 81-item self-report instrument used to assess a college student's motivation and the use of learning strategies in a particular college course (Pintrich, 1991). It contains two scales, Motivation and Learning Strategies, and 15 subscales. The instrument was designed to be used as a whole or delivered in parts. This study utilized two subscales, metacognitive self-regulation and self-efficacy (Table 1).

This study utilized the pre-test/post-test research design. Both pre-test/post-test administration of the self-regulation and self-efficacy subscales of the MSLQ were uploaded and delivered to BIOS participants through Survey Monkey, an online survey management system. An email with a link to the questionnaire was disseminated to their university email accounts approximately two weeks before BIOS. BIOS participants were required to complete the questionnaire as part of their program registration. The post-test and control administration was completed at the end of the fall semester. BIOS participants received their post-evaluation via email. The control group was solicited for voluntary participation by accessing the questionnaire via a link in their respective Biology 1201 learning management site, Moodle. Researchers did not give the control group a pre-assessment. This decision was based on the pilot research data that suggested that the control and experimental groups have similar pre-motivational characteristics (Wischusen and Wischusen, 2007).

Final course grades of BIOS participants and control group were obtained from instructors and institutional records.

Statistical Package for Social Sciences (SPSS) software was utilized for all statistical analysis. A data reduction of the MSLQ was performed using principle component analysis to ensure that all items translated into two distinct components of self-efficacy and self-regulation, as documented by the MSLQ manual. Internal reliability was performed using Cronbach Alpha's Coefficient. To obtain a subscale score, the mean of the self-efficacy and self-regulation subscales was computed for each participant. These subscale scores were then used in a paired-sample t-test analysis to determine if there was a difference in the pre- and post-administrations of the MSLQ of the BIOS participants. A one-way ANOVA was also used to determine the difference between the post-administration scores of the experimental and the control group. A regression analysis was performed to gauge the variance that self-efficacy and self-regulation contributes to final introductory biology grades for both the experimental and control groups.

Results

Pre-test Analysis & Results

On a Likert scale from 1 ("Least Like Me") to 7 ("Most like Me"), participants reported an average of 5.72 (SD = 0.763) on the self-efficacy scale and an average of 5.14 (SD = 0.835) on the self-regulation scale (Figure 1). A similar pattern emerged when results were compared to the previous year. BIOS 2010 students' (N=285) self-efficacy and self-regulation evaluations were 5.51 (SD=0.792) and 5.05 (SD= 0.753), respectively.

Post Test Analysis & Results

BIOS participants completed post-survey at the end of the fall semester. Paired t-test analysis of the pre- and post-administrations revealed a trend in both the 2010 and 2011 BIOS cohorts. Only students who completed both a pre- and a post-survey were included in this analysis. Out of the original sample of 577, 263 completed both a pre- and a post-survey. As shown in Figure 1, there is a decrease in scores in both subscales from pre to post reports. However, only self-regulation shows a statistically significant decrease.

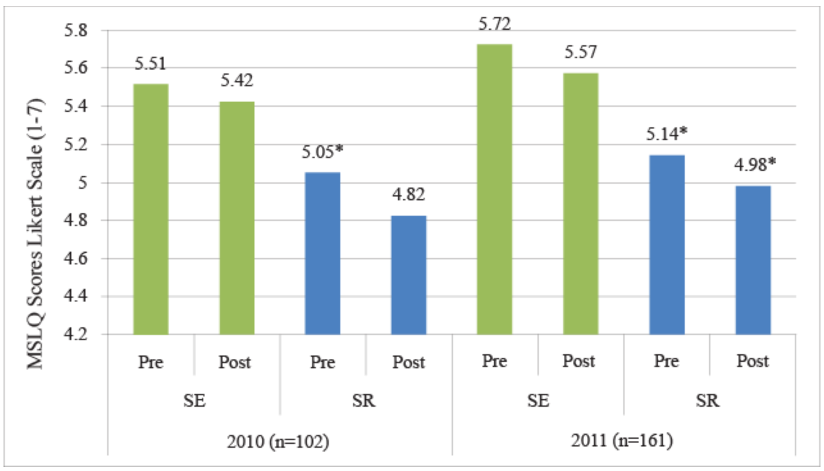

Figure 1. Comparison in Pre-Post Self-efficacy and Self-regulation of BIOS participants. *, significantly different from post score (Paired t-test).

Motivated Strategies for Learning Questionnaire (MSLQ)

The purpose of this questionnaire is to gather some information about your study skills, learning skills, and motivation for your school work in relation to your biology classes.

Directions: If you think the statement is very true of you, fill in the circle on 7; if a statement is not at all true of you, fill in the circle on 1. If the statement is more or less true of you, find the number between 1 and 7 that best describes you.

1. I think I will receive an excellent grade in this class.	11. When I become confused about something I'm reading for this class, I go back and try to figure it out.
2. I'm certain I can understand the most difficult material presented in the readings for this course	12. If course readings are difficult to understand, I change the way I read the material

3. I am confident that I can learn the basic concepts in this course.	13. Before I study new course material thoroughly, I often skim it to see how it is organized.
4. I am confident that I can understand the most complex material presented by the instructor in this course.	14. I ask myself questions to make sure I understand the material I have been studying in this class.
5. I am confident that I can do an excellent job on assignments and tests in this course.	15. I try to change the way I study in order to fit the course requirements and the instructors' teaching style.
6. I expect to do well in this class.	16. I often find that I have been reading for this class but don't know what it was all about.
7. I'm certain I can master the skills being taught in this class.	17. I try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying for this course.
8. When considering the difficulty of this course, the teacher and my skills, I think I will do well in this course.	18. When studying for this course I try to determine which concepts I don't understand well.
9. During class time I often miss important points because I'm thinking of other things.	19. When I study for this class, I set goals for myself in order to direct my activities in each study period.
10. When reading for this course, I make up questions to help focus my reading.	20. If I get confused taking notes in class, I make sure I sort it out afterwards.

Table 1. Motivated Strategies for Learning Questionnaire. This study utilized only twenty items from two subscales, self-efficacy and metacognitive self-regulation.

BIOS Participants versus Control Group

In 2010, there were 102 participants in the experimental group, while there were 303 participants in the control group. In 2011, there were 248 participants in the experimental group, while there were 520 in the control group. BIOS participants’ post scores were compared to their Biology 1201 peers who did not participate in BIOS. Figures 2 and 3 show that BIOS participants had a higher self-efficacy, self-regulation, and final Biology 1201 grade than the control group. All differences were statistically significant.

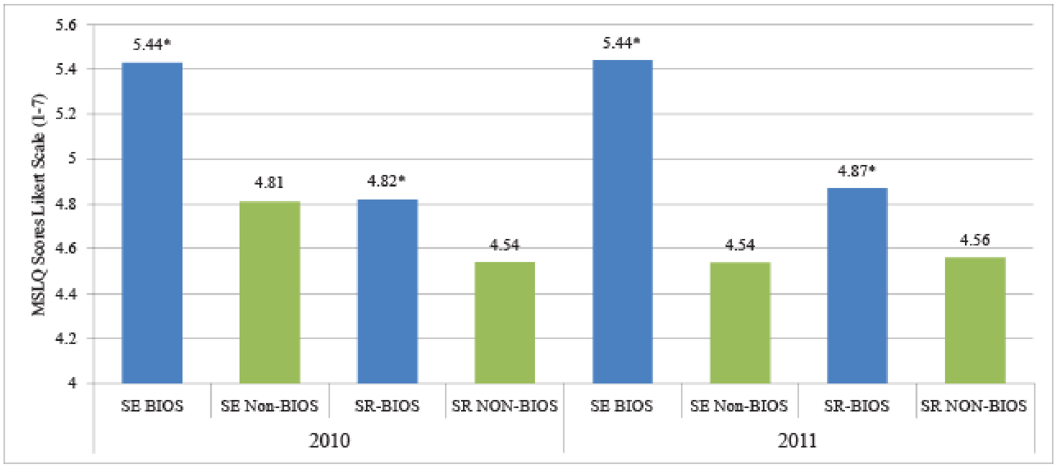

Figure 2. Comparison of SE and SR for BIOS participants and Control Group. BIOS 2010 (n=102), Control 2010 (n=303), BIOS 2011 (n=248), Control 2011 (n=520). *, significantly different from control group ($p < 0.001$, One-way ANOVA).

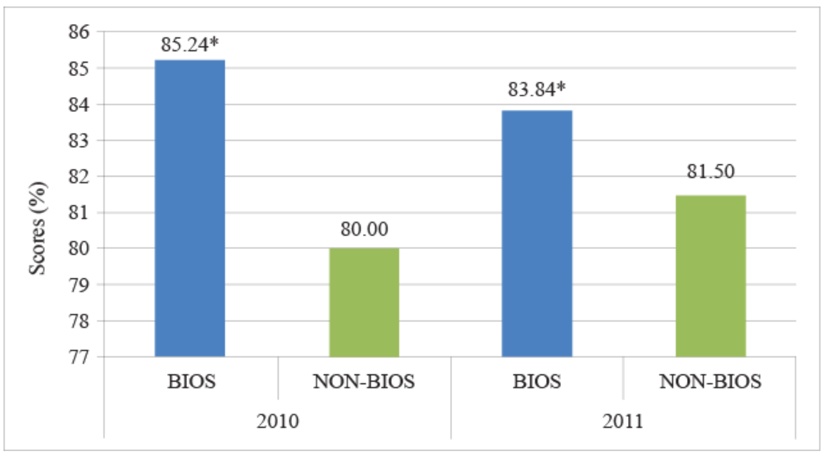

Figure 3. Comparison of Final Biology 1201 Grades for BIOS participants and Control Group. BIOS 2010 (n=102), Control 2010 (n=303), BIOS 2011 (n=248), Control 2011 (n=520). *, significantly different from control group ($p < 0.001$, One-way ANOVA).

Regression analysis of BIOS participants and non-participants survey scores and final course grades revealed that both self-efficacy and self-regulation were significant predictors of Biology 1201 performance. Self-efficacy was a better predictor of course performance than was self-regulation. As shown in Figure 4, self-efficacy accounted for 43.5% of the variance in course performance of those students enrolled in Biology 1201 in 2010 and 2011. Self-regulation accounted for about 9% of the variance. Other unexplained factors accounted for the remaining variance.

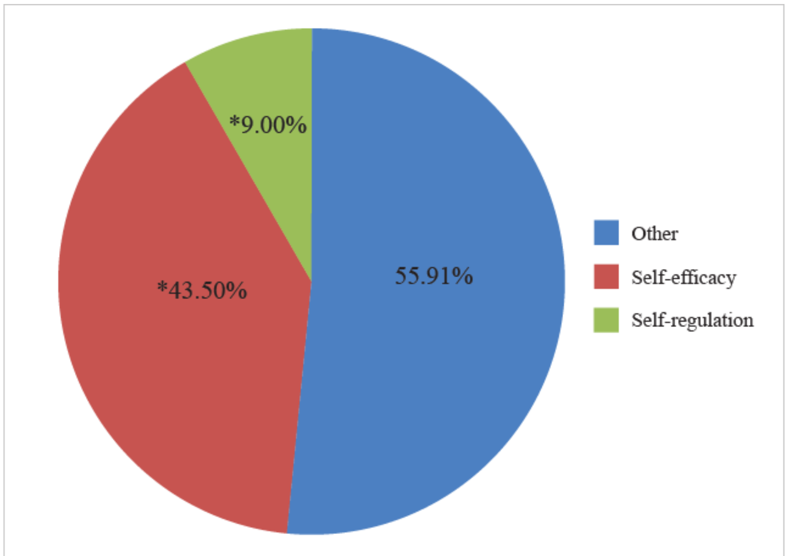

Figure 4. Average SE and SR contribution to variance in Biology 1201 grades for BIOS participants and Control Group for BIOS 2010 and 2011. BIOS 2010 (n=285), BIOS 2011 (n=785). *, significant ($p < 0.001$, Regression Analysis).

Discussion

BIOS calibrated students' self-regulated learning and self-efficacy for optimal performance in introductory biology.

Results show that there was a decrease in self-efficacy and self-regulation from pre- to post-administration of the survey. Students' self-accounts of a slightly higher self-efficacy than self-regulation concurs in the research of Jensen and Moore (2008). In gauging the relevance of high school science performance to college science success, researchers' pre-semester surveys revealed that students were highly confident that they were prepared to succeed in the course. However, students' responses also indicated that the level of academic discipline did not translate to same level of confidence.

Superficially, a decrease in both self-efficacy and self-regulation can be viewed as BIOS having a null effect. However, self-efficacy and calibration literature indicates that the results can be interpreted to the contrary.

Calibration refers to how well self-efficacy relates to actual performance on the corresponding task (Pajares & Kranzler, 1995; D. H. Schunk & Pajares, 2009). People are considered to be well calibrated when they can use their self-efficacy to accurately predict their performance (D. H. Schunk & Pajares, 2009). Perfect calibration can occur when individuals expect to perform well and they actually do or when individuals expect not to perform well and they actually do not. Poor calibration occurs when people overestimate or underestimate their abilities and predicted performances are not executed. In the academic setting, overestimation of self-efficacy can sometimes result in failure that lowers motivation (Schunk & Pajares, 2009).

Students who do not recognize the requirements and amount of effort needed to complete a task successfully usually overestimate their actions. However, Bandura suggests that a slight overestimation of confidence is needed for increased effort and motivation that leads to optimal performance (1997). In instances of slight overestimation, students prepare to seek help in closing the gap between skills they possess and those they lack.

When predicting future performances, individuals must have a basis for making their predictions. According to Bandura's self-efficacy theory (2010), past experience is the greatest influence on self-efficacy. The easier the experience, the greater individuals' self-efficacy is developed. Because the only way to measure self-efficacy is by self-report, scores on the MSLQ represent the perception of students' ability to conquer Biology 1201. Their perception is justly based on their most recent past experience, high school biology. Based on interviews and institutional data, most participants have received no less than a "B" in their science classes and have taken advanced placement science courses. However, students also noted that they considered their science courses to be relatively easy and required minimal study time. Therefore, it is likely that their positive high school experience influenced the pre-scores. It is also likely that students overestimated their self-efficacy. Individuals have a greater tendency to overestimate their confidence for completing future tasks when experiences have had little to moderate difficulty. Although not statistically analyzed, the evaluation of BIOS exams scores reveal students may have overestimated their confidence. The 2010 BIOS cohort had a 60% average on all exams and the BIOS 2011 cohort had a 70% average on all exams. While the context of learning the material was different from a normal college setting, the material itself was the basics of biology. Students even commented that they were comfortable with the material because they were familiar with it from high school. Considering the initial self-efficacy scores and familiarity of the content, the BIOS exam scores averages are very different from the "A" or "B" high school grades the participants were accustomed to receiving.

After completing BIOS and more than half of the fall term, participants replaced their high school experience with more current and accurate experiences. Participants reported a lower rating of self-efficacy. Literature explains that self-efficacy decreases with increase in difficulty (Mats, 1992; Stone, 2000). If pre-scores reflect overconfidence, then post-scores may represent participants' calibrated scores. The change in self-efficacy can be seen as participants calibrating their self-efficacy based on actual experiences in Biology 1201. Since overconfidence has been found to contribute to the failure rates in introductory science courses, decreasing students' confidence to an optimal level for academic success is a plausible solution for retaining students. Pre/post comparisons of self-efficacy indicate that BIOS helped to deflate detrimental high self-efficacy.

The decrease in self-regulation can be explained in a similar way. Because students did not perceive high school biology to be a challenging course, effective learning strategies were not employed, hence the low self-regulation mean in comparison to self-efficacy. However, the initial self-regulation is higher than the post self-regulation. The high pre self-regulation scores can be a consequence of overconfidence. If they overestimated their confidence, it is possible that students overestimated their use of self-regulatory techniques. In using software that measures evidence of self-regulation, researchers found that students were over-confident and overestimated their use of self-regulatory techniques (Winne & Jamieson-Noel, 2002). Once students were exposed to the variety of learning strategies and became familiar with the cognitive demands of Biology 1201, they became more aware of themselves as college learners. After understanding the requirements for successfully completing Biology 1201, participants underestimated their degree of self-regulation. Underestimation of self-regulation can be an indication that students seriously scrutinized their own academic behaviors and created room for improvement.

Self-efficacy is a strong predictor of academic success.

Regression outcomes signify that a student's motivation is important to academic performance. Although the use of self-regulatory strategies is critical, students must be intrinsically motivated to use these strategies. The drive that students possess can differ from course to course. Therefore, self-efficacy must be specifically developed (Choi, 2005).

Results are parallel to outcomes of other research studies in which self-efficacy was the best predictor of academic performance (Zimmerman, 1992; Klomegah, 2007). Kitsantas (2008) and colleagues found that self-efficacy was more important to success in the first year of college than any other year. Other researchers have also validated the predicative power of self-efficacy in the first year (Devonport & Lane, 2006; Museus & Hendel, 2005; Ramos-Sánchez & Nichols, 2007; Zajacova, Lynch, & Espenshade, 2005). Although literature points to the context dependency of self-efficacy, there is a lack of research that validates this notion within the specific context of a particular course or special academic intervention (Finney & Schraw, 2003; Jerome & Henk, 2009).

Conclusion

This study aimed to evaluate the effect of an academic orientation program on the self-efficacy and self-regulation of freshman biology majors. Previous studies of BIOS presented grades and retention data as confirmation of its effectiveness. The current study provides evidence that BIOS affected the performance of its participants through developing self-efficacy and self-regulation. BIOS incorporates several factors supported by literature that cultivate self-efficacy and self-regulation. The program explicitly taught students how to learn through practical metacognitive strategies and contained various elements that strengthen self-efficacy. The program also utilized several principles of quality feedback. Quantitative data confirmed the impact of these elements. BIOS helped to calibrate students' confidence and self-regulation for optimal performance in Biology 1201. Participants performed better than their non-participating peers, and with higher confidence.

The results of this study show that a biology-intensive orientation has a positive effect on performance, motivation, and metacognition of first-year science students. This format can be a powerful solution to combat STEM attrition at the introductory course level and thereby increase STEM professionals across the US.

This study supports the idea that self-efficacy is an important motivational construct. Self-efficacy directly influences the use of self-regulatory techniques and plays an important role in course performance. Educators can target the development of self-efficacy and self-regulated learning in their classrooms in the absence of a boot camp. Instructors could design assignments that gradually increase in difficulty. They could also give constructive, realistic and encouraging feedback to students in a timely manner. Implementing these tools will enable students to accurately gauge their performance and maintain a consistent sense of self-efficacy.

Control of metacognition also plays a significant role in classroom success. Some educators are not aware that the difficulty of content is not always to blame for students' failure in a course. Most students are unaware of how to process the information to facilitate higher order thinking. Teaching students how to learn can aid them in comprehending the most challenging material. Educators can dedicate a small amount of time during the first lecture to introducing students to metacognition and practical learning strategies. During this time, instructors can show students a comparison of behaviors of successful students and unsuccessful students. This sets a standard to which students can model their behavior. To help students become aware of themselves and monitor their progress, teachers may include a simple pre- and post- assessment of confidence and learning strategies on exams. When students receive their grades, they can evaluate their learning strategies and confidence prior to exam that led to their scores.

Because this study focused only on a biology boot camp at one university, there are multiple opportunities to expand the research. Investigations can compare the boot camp's effect among STEM disciplines. While a large number of students declare biology as a major, other STEM majors have significantly fewer students. Therefore, a boot camp may have a greater effect on less-populated STEM majors by creating a stronger learning community. Because there are several universities that have shown interest in the BIOS model, future investigations can explore the success of the format with other populations.

While minority populations were not a focus of this study, there may be valuable information in discovering how boot camps affect the self-regulation, self-efficacy, and retention of underrepresented groups. Engineering education literature has shown that summer bridge programs have significant influence on self-efficacy of both women and ethnic minorities (Hutchison et al., 2006; Hutchison-Green et al., 2008).

Future research investigations should include qualitative interviews and surveys from the orientation participants, as well as the non-participants. Including the qualitative methods could render more information on the differences in motivation between those enrolling in the camp and those who did not. These data can help administrators target recruitment efforts for camp participation. The additional information can also help develop secondary interventions for those students who did not attend the camp and were not successful in their introductory course.

Another research method modification proposed for future research is the addition of other subscales of the MSLQ. Although this study only used the metacognitive self-regulation scale in the interest of validity, other subscales were strongly related. The cognitive and metacognitive strategies of rehearsal, elaboration, and organization were heavily discussed in the learning strategy sessions during BIOS. These areas were evaluated in the qualitative surveys. However, a correlated quantitative evaluation may have further reinforced conclusions. Adding these subscales could have also answered the unaccounted variance in course performance.

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