

STUDENTS' PERCEPTIONS OF 'SUCCESS': A BIOLOGY STUDENT RETENTION PROGRAM

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Doi: <https://doi.org/10.34107/KSZV7781.10392>

ABSTRACT

It is no secret that the retention of students majoring in Science, Technology, Engineering, and Mathematics (STEM) has presented itself to be a challenge across the country. The National Science Foundation (NSF) allots substantial funding annually towards this effort. Jackson State University's (JSU) *Students Understanding Chemistry Concepts to Enhance STEM Skills* (SUCCESS) Program is one such effort funded by the NSF. While the JSU Department of Biology had over 900 majors in 2016, data suggested that less than 23% would graduate with a bachelor's degree within six years of entry. According to data obtained, the first four chemistry courses, General Chemistry (I & II) and Organic Chemistry (I & II), were significant barriers to the educational success of many Biology majors. A review of the literature provides many examples of initiatives to improve student retention. A reoccurring theme found that the comprehensive understanding of the students' experiences within a particular major is essential to determining how best to impact student retention in that department. Student focus groups were implemented to evaluate the perceptions of Biology majors enrolled in Chemistry classes who utilized the SUCCESS Program. The overall impression of students in the SUCCESS Program was that it was helpful and beneficial to their classroom success, increased their confidence to learn Chemistry, and improved their understanding of Chemistry concepts. The students often identified scheduling conflicts as a hindrance to their participation. They also felt that the program was needed to help most students pass their tests.

Keywords: STEM, Retention, Biology, Chemistry, Perceptions, Pedagogy

INTRODUCTION

It has been noted that millions of Science, Technology, Engineering and Mathematics (STEM) careers in the United States (U.S.) will develop over the next decade and there will be a need for bachelor- or associate-level STEM degrees in this country [1]. Therefore, it is paramount that the country put forth a substantial effort to meet its imminent STEM need. In concurrence, flaws in the current U.S. science education sector have resulted in pedestrian performances in the areas of recruitment, preparation, and graduation of a diverse, next generation cohort of scientist and engineers large enough to drive the future workforce in the U.S. STEM enterprise [2]. In 2014, underrepresented minority groups (URMs) made up 31% of the U.S. population; however, they earned only 21% of all STEM bachelor's degrees [3]. Because of this, a lot of effort is focused on recruiting and retaining students, especially minority students, in STEM areas. In fact, since 2013 the National Science Foundation (NSF) has allocated more than \$800 million each year towards this effort [4]. The current grant, entitled "*Students Understanding Chemistry Concepts to Enhance STEM Skills*" (SUCCESS), is one such effort funded by the NSF.

Concept of SUCCESS

The Department of Biology at Jackson State University (JSU), an urban, research intensive, Historically Black College or University (HBCU), was experiencing a low graduation rate among its majors. Biology had the distinction of being the largest major in the JSU College of Science, Engineering,

and Technology (CSET). While the department had over 900 majors in 2016, institutional data obtained from the JSU Office of Institutional Research (OIR) suggested that less than 23% would graduate with a bachelor's degree within six years of entry. According to data obtained from the JSU ORI, the first four chemistry courses, General Chemistry (CHEM 141; CHEM 142) and Organic Chemistry (CHEM 241; CHEM 242) were major barriers to the educational success of many biology majors at the university. Prior decades of research referred to such courses as "gatekeeper" courses; however, the term "gatekeeper" has since been redefined as "the first or lowest-level college-level course students take in a subject such as mathematics, reading, or writing" [5]. Recent studies use the term '*barrier courses*' to refer to the courses that have a high failure rate, which in turn prevents many students from obtaining their degrees [6]. These four Chemistry courses were barrier courses to Biology majors at JSU. To address this issue, faculty members from the College of Education and Human Development (CEHD) and CSET partnered to design a comprehensive, student-centered learning plan, which resulted in the development of the SUCCESS grant to improve the low 6-year graduation rate among Biology majors.

The SUCCESS Program was offered as a course identified with a specific course registration number. Students were registered for the course by the department's assistant chair/co-principal investigator. Some students volunteered to enroll in the course; however, some students were selected to be registered for the course based on unsatisfactory prior attempts to earn credit hours with a grade of "C" or above.

Conceptual Framework of Using Pedagogy

To reach this goal of improving the graduation rate of Biology majors at JSU, changes in pedagogical methods were introduced. The methods the JSU SUCCESS Program chose to implement were Process Oriented Guided Inquiry Learning (POGIL) and a Supplemental Instruction (SI) called Chemistry Drill. Research has shown that certain pedagogical methods can increase STEM students' learning and improve their grades. Also, there appears to be a direct positive correlation between GPA and student retention [7]. Transforming student instruction from conventional to student-focused learning environment requires innovative, research-based, educational strategies [8]. One of these said instructional practices is POGIL [9,10]. Moog and colleagues [11] extensively explained that the overall goal of the POGIL method was to utilize the student's own understanding of a particular subject matter to develop course content proficiency. Furthermore, the POGIL technique cultivates noteworthy learning skills such as: information assessment, oral and written messaging, critical and analytical thinking, and metacognitive problem solving activities [11]. In addition to POGIL, another instructional mechanism is SI. While POGIL occurs during the normal class hours, SI occurs outside the lecture or lab classroom [12]. Research data indicates that SI participants have higher than average course grades and lower attrition rates than their non participant counterparts [13]. Working with faculty in the Chemistry Department, Biology personnel assigned Biology majors to Chemistry courses (General Chemistry I & II and Organic Chemistry I & II) identified as SUCCESS courses due to their inclusion of POGIL and the SI (i.e., Chemistry Drill) instructional mechanisms facilitated by the JSU SUCCESS Program administrators.

Student Perceptions

A review of the literature provides many examples of initiatives to improve student retention. However, as noted by Biggers and colleagues [14], "to determine how best to impact student retention in your department, a comprehensive understanding of the student experience of your major is essential. Not only is it important to know why students leave your major, but an understanding of why they stay can be useful in developing high impact initiatives". Ultimately, understanding the specific needs of your students is important. According to Tinto [15], the onus of addressing the issue of retention at an individual

institution falls upon that particular institution. Researchers have identified the use of student survey data

as a means of determining what students believe they need. Additionally, student surveys can also be used to evaluate students' perceptions about the services they are receiving [16]. Another method of obtaining data is through the use of focus groups. A focus group study collects qualitative data by engaging groups of students in an informal group discussion 'focused' on their perceptions of the program in which they are participating [17]. This information may help students and possibly improve retention and graduation rates [16]. The purpose of this article is to review the perceptions of JSU Biology majors enrolled in Chemistry classes utilizing teaching techniques applied within the SUCCESS Program.

METHODOLOGY

Surveys and focus groups were employed to collect qualitative data representative of the larger population [18]. Students who enrolled in SUCCESS courses were invited to complete a 17-question survey at the end of the course. The survey collected demographic data about the student and also included open-ended questions geared to collect the students' perceptions of the course instruction and supplemental instruction offered through the SUCCESS Program. Surveys, devoid of any self-identifying information, were submitted anonymously through Survey Monkey, an online survey and data analytic tool. These surveys were used to find out if the resources offered by the SUCCESS Program were beneficial in helping the student complete their respective Chemistry courses without having to repeat it, while simultaneously identifying what the students felt was most beneficial to their completion of the course. The information gathered was further gleaned via follow-up focus group discussions facilitated through the external evaluator. The importance of the data collected was that it assisted faculty and administrators in the development and implementation of effective teaching regimens designed to ensure students gained a better understanding of materials being taught in the classroom. Ultimately, this process will translate into improved degree completion rates for Biology majors.

Limitations

Limitations of this study included:

1. The authors assume students answered truthfully to the questions in the survey and focus groups.
2. The COVID-19 pandemic brought about changes to students' schedules and access to certain resources.

Delimitations of this study included:

Only Biology majors enrolled in one of the four-targeted Chemistry courses were invited to participate in the surveys and focus groups.

RESULTS

Year 1- Spring 2018 Semester: A first semester General Chemistry course, with an initial enrollment of sixteen (16) students, was implemented for the spring 2018 semester. Fourteen (14) out of the sixteen (16) students were Biology majors. Demographics revealed that 75% of the students were female and 25% male. A majority of the students were classified as juniors, with most of the students self-reporting a “C” letter overall grade point average (GPA) ranging from 2.5 - 2.9 on a 4.0 scale. The General Chemistry course consisted of 150 minutes of active learning lectures that involved POGIL activities and 90 minutes of Chemistry Drill activities each week. Three students switched to another section of General Chemistry within the first week of

the course. Only twelve (12) the SUCCESS Program of the students attended should be mandatory for all lecture on a regular basis and students majoring in Biology remained in the course until and the end of the semester. All of the students expressed positive views and wished that the SUCCESS Program would be implemented in all of their Chemistry classes (Figure 1). They believed that

SUCCESS Program as Beneficial

Year 1 Year 2 Year 3

0% 20% 40% 60% 80% 100% 120% %

Students Perceived Beneficial

Students Perceived

Chemistry because it assisted them to better understand chemistry concepts and formulas from

a
Figure 1. Student Perceptions of the SUCCESS Program's Benefits

different vantage point. Another common theme repeatedly expressed by the students was that the SUCCESS Program gave them the confidence to participate in peer tutoring and provide helpful instruction to their fellow classmates. One student expressed that he never believed he could help his fellow classmates understand chemistry concepts until now.

The challenges expressed by the focus group demonstrated their mixed feelings with SUCCESS weekly Chemistry Drills. On the one hand, the students felt that the Chemistry Drills were very valuable and helped them better prepare to pass the exams. However, on the other hand, the students felt the Chemistry Drills should not be mandated weekly and that the amount of work associated with this SI should not outweigh the work associated with the class. The students also felt strongly that the instructor who teaches their Chemistry class should also be their Chemistry Drill instructor. “It should not be two different instructors because of the different teaching styles and methods” was a reoccurring comment made by the members of the group. They felt that consistency in teaching would provide more continuity and contribute to their overall success in the particular Chemistry course they were taking. In addition, the students reported that they were willing to be advocates for the SUCCESS Program and that they believed more students should take advantage of the opportunity.

Year 2- Students enrolled in General Chemistry I & II and Organic Chemistry I courses in Academic Year 2019 responded to a survey, which was designed to measure their experiences in the SUCCESS Program. Forty-five (45) students voluntarily completed the survey. Seventy-one percent (71%) of the students responding to the survey stated that they expected to pass the course receiving a grade of “C” or

above, while 29% of these students had enrolled in the exact same course more than once. The majority

of the students (59%) indicated that they did not attend the SUCCESS Programs Chemistry Drill sessions. Students in the three Chemistry classes who did attend the Chemistry Drill sessions found them to be “somewhat helpful”. The students in focus groups shared that they “learned a lot” and felt they were “able to comprehend because of the way the teacher explains the material”. In terms of POGIL instruction, SUCCESS students identified “we do worksheets, group work, review, and go over material we don’t understand”. Furthermore, the students seemed to enjoy POGIL instruction stating, “With the new approaches, we do more than just reading the text book”. SUCCESS students also seemed to enjoy smaller class sizes over larger ones. They stated, “we need more classes like POGIL that are small because it will help us prepare for our next class”.

Some of the perceived challenges expressed by students in the SUCCESS Program included: the students’ inability to miss any Chemistry classes because they could easily fall behind; the students’ understanding of the need to study hard because Chemistry is a challenging course; and the students’ realization that using a supplemental on-line homework program called CHEGG was not very helpful.

Also, most students indicated during the focus group sessions that they benefited from problem solving and the instructional methods, while a smaller percentage of students felt the instructional methods did translate into classroom success (Figure 1). Their comments included that this approach did not allow them to see a “full-picture” of concepts being presented and expressed the desire to spend more time receiving personal instruction on the subject matter.

Year 3- Students enrolled in General Chemistry I & II and Organic Chemistry I & II courses responded to questions regarding their experience with the SUCCESS Program in Academic Year 2020. The third year of implementation of the program was greatly impacted by the onset of the Coronavirus Pandemic. The transition to a virtual setting brought about unforeseen stresses for students, faculty and administrators. One of the adjustments made by the institution in wake of the pandemic was to put forth a modified grading system. Students were allowed to choose whether to: 1) accept the letter grade they made in the course, 2) receive credit for participating in the course (PX), or 3) receive no credit for the course without it affecting their GPA.

This year only 26 students were questioned and it was via a focus group setting only, which took place prior to the pandemic. The majority of the students (69%) indicated they liked POGIL, six (23%) responded “don’t know” and one student did not answer. Only 42% of the 26 students who responded attended the Chemistry Drill sessions on a regular basis. The time schedule was the major factor that influenced their lack of attendance. Again, 42 % of the students who attended peer tutoring expressed that scheduling negatively impacted their participation in the Chemistry Drill sessions.

The majority of the students responding (62%) found the SUCCESS Program to be beneficial to the achievement of their personal goals for the program (Figure 1). Some of their responses to the benefits of the program included: increasing their confidence to learn chemistry, not feeling defeated by Chemistry courses, leaving with an understanding of Chemistry concepts, and achieving a grade of “A”. Nineteen of the students (73%) felt that more students should take advantage of the educational benefits provided by a program like SUCCESS, and all of the students responding indicated that they would advocate for the SUCCESS Program for all students enrolled in Chemistry courses.

DISCUSSION

In an attempt to maximize learning outcomes for Biology students enrolled in Chemistry courses,

increasing students' attendance to Chemistry Drill sessions is one of the major challenges that the SUCCESS Program's leadership has continued to grapple with. The reoccurring frequency of students noting that personal scheduling issues negatively impacted their attendance to Chemistry Drill sessions, as well as the SUCCESS Program's documented struggles surrounding getting students to voluntarily attend the Chemistry Drill sessions present themselves as points of discussion. These two major discussion points were derived from an analysis of the perceptions and actions of students participating in the SUCCESS Program.

SUCCESS students identified the personal scheduling of their time as an issue that prevented them from attending Chemistry Drill sessions. In an attempt to rectify this problem, alternate time-slots for the Chemistry Drill sessions were created. However, the SUCCESS Program's offering of various days for its students to participate in the Chemistry Drill sessions did little to significantly improve attendance. The issues surrounding student participation in outside activities and how it affects their performance in school have been thoroughly researched, however the implementation of solutions that adequately resolve this dilemma have lagged behind. In this day and time, more students are working long hours on jobs outside of their school's campus; conversely, research findings demonstrate that working outside jobs negatively affects students' performance in school [19, 20, 21].

The pattern of off-campus hourly work rate reported by SUCCESS students was inconsistent (Figure 2). In Year 1 of the SUCCESS

Program, a large majority of the students surveyed identified that they worked off campus for more than 20 hours per week. This pattern was reversed in Year 2, with a large majority of the students surveyed identifying that they were not working more than 20 hours per week off campus. This data was not collected for Year 3 because of the COVID-19 pandemic. However, from personal interactions between JSU faculty and students, the pandemic's effects on family household income caused many JSU students to have to find SUCCESS Students

Working Off Campus More than 20 Hours Per Week

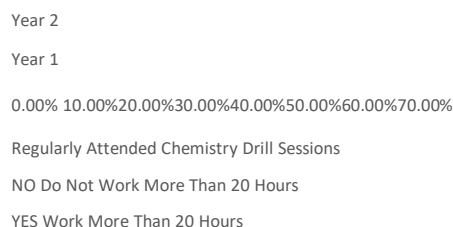


Figure 2. SUCCESS Students' Off-Campus Hourly Work Rate

Year 3 No Data (Due to pandemic)

full- or part-time jobs to help supplement their family's financial needs. In looking at ways to alleviate this problem, special attention should be given to the availability and distribution of financial aid and how it is calculated so that students are able to sufficiently survive without having the necessity to work long hours at jobs off campus.

CONCLUSIONS

The overall impression of the SUCCESS Program is that students perceived it to be helpful and beneficial to their understanding of Chemistry concepts (Figure 1). The students often identified scheduling conflicts as a hindrance to their participation in the SUCCESS Program's supplemental training activities. They also felt that although the program may not be the best for all students, it was definitely helpful in supplying the support needed for passing Chemistry exams. Finally, the program administrators found the information gained from this study and the student participants' perceptions helpful in the planning, designing, revising, and implementation of supplemental activities geared towards improving the number of Biology majors obtaining satisfactory grades in Chemistry courses for each semester of the academic years within the three-year grant.

ACKNOWLEDGMENTS

The authors acknowledge the financial support of the National Science Foundation (NSF- 1712477) for their financial support, and Drs. Tom Cheatham, Louise Jones, and Janet Privett (Xavier University) for their invaluable contributions to this study.

DISCLOSURES

Author Barbara L. Howard **Financial Disclosures:** None **Conflicts of Interest:** None

Author Timothy Turner **Financial Disclosures:** None **Conflicts of Interest:** None

Author Naomi Campbell **Financial Disclosures:** None **Conflicts of Interest:** None

Author Barbara Graham **Financial Disclosures:** None **Conflicts of Interest:** None

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ISSN: 1938-1158 01 57 3 398 ISBN: 978-1-989527-10-8

Biomed Sci Instrum Vol 57(4) October 2021 ©2021 IAE All rights reserved

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