Program Subject/Problem

Within the U.S. less than half of students who start college majoring in a STEM field earn a degree in STEM (PCAST 2012). Attrition is more pronounced in underrepresented groups (PCAST 2012) with women, underrepresented minorities, 1st-generation students and low-income students leaving college at a higher rate (Engle and O'Brien 2007; Whalen and Shelley, II 2010). One of the main factors that contributes to attrition from STEM majors is student experiences in their introductory courses (PCAST 2012).

To address this concern, programs or interventions should focus on the first year(s) of college, as this offers the best chance to improve student experiences. Focusing on academic success early in a students' college career can lead to higher persistence since students who are successful in their first years are more likely to persist (Shaw and Barbuti 2010). One method to create engaging and active learning experiences for students in their first year is to utilize research experiences which have been shown to increase student persistence in STEM (Rodenbusch et al. 2016).

The academic system is complex and to positively influence persistence one must consider integrating both academics and social components (Tinto 1975). An academic system should focus on quality of teaching, student experiences within introductory courses and first year success while a social system should provide support services, mentoring and learning communities (Graham et al. 2013; Engle and O'Brien 2007). The persistence framework suggests utilizing early research experiences, active learning and learning communities as a means to support motivation, confidence and science identity (Graham et al. 2013).

Biology is not immune to the substantial attrition rates observed in STEM (Chen 2013) and could gain form improvements in program and course design. The purpose of this study was to develop a comprehensive program that merge features of research, skill development and social structures into a single program. The program that emerged, RISEbio, is for students majoring in biology and is meant to provide a research experience bridge between their 1st and 2nd years of college as well as focusing of social support structures.

The main goals of this program are to increase students 1st time pass rates of introductory biology courses, increase 4-year graduate rates and decrease drop-out major rates which are all lower for low-income students compared to their peers at the institution where this program was designed and implemented. Our last goal was to increase overall academic success. To achieve these goals, the program outlined three main objectives: increase social integration and student support, develop student technical and professional skills, implement a freshman immersive research program.

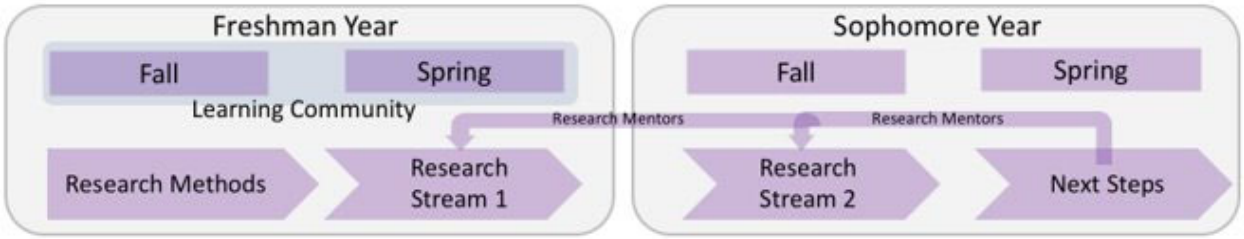
Design/Procedure

RISEbio program

RISEbio is funded by an NSF S-STEM (17-527) grant however students do not need to qualify for a scholarship in order to participate. Scholarship funding is determined by the students' expected family contribution (EFC). In addition to EFC, students are selected through an application process where they were evaluated based on their academic ability, interest in biology and the RISEbio program and whether he/she was from an underrepresented group (e.g. student of color, veteran and/or 1st generation).

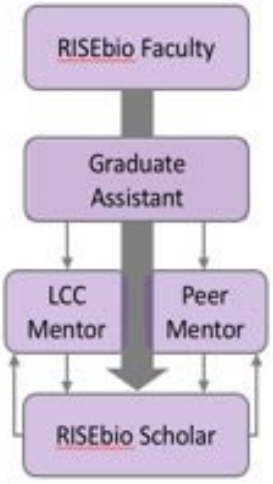
RISEbio is unique in that not only does the program incorporate early undergraduate research experience but it also has an integrated student support system. The research experience is a three-course series (Figure 1). The 1st course students complete during their 1st semester, is a research methods-based course designed to teach core concepts and methodology in biological research (e.g. statistics, microscopy and scientific method etc.). In the 2nd semester students

Figure 1. Structure of RISEbio program.



select a research stream to join, where they work in pairs to investigate a novel open-ended research question. This research stream carries over into the fall of their 2nd year. Currently, there are two research streams one that investigates the relationship between brain and behavior and the other examines the role of immunity in cancer. Students continue the research into their 3rd semester. The courses as part of the program either substituted for their introductory biology labs or count as an upper level elective.

Figure 2. Vertical mentorship structure.



The social support system implemented as part of the program relies on two main components (Figure 2). During their freshman year, students are part of learning community which entails completing the same courses, living on the same residence hall floor and participate in community projects. The learning community coordinator (LCC) and peer mentors, except for the 1st year when the program started, are former RISEbio students which helps provide a vertical mentorship component to the program. After the program has ended, students also can complete additional research projects within the same discipline or in a different research area. Cohorts for the program are staggered but concurrently run with a cohort in its 1st year overlapping with a cohort in its 2nd.

Assessment and Evaluation

RISEbio students completed survey instruments as part of their participation to measure their views and attitudes towards their major, goals, well-being, confidence and motivation (Table 1) as there is a relationship between persistence, success and their metrics (Graham et al. 2013; Russell et al. 2007). A comparison group was formed through recruiting students from the first biology introductory sequence course but were not part of the RISEbio program. These traditional students completed the same instruments and were tracked along the same timeline as the RISEbio students. RISEbio students at the end of their 4th semester completed an additional survey questions regarding their undergraduate research experience that the traditional students did not. As of Fall 2020, the 1st cohort completed the program, the 2nd cohort is starting their 3rd semester and the 3rd cohort is starting their 1st semester. This is a longitudinal study and students will continue to be tracked beyond the completion of the program to continue determine

persistence and graduation rates. In addition to the internal assessment this program has undergone external evaluation to monitor program progress, inform revisions and improvement and to document project-level impacts. The findings presented in this proposal will focus on the goals and objectives outlined in the previous section.

Table 1. Timeline for survey instrument implementation for RISEbio and the traditional students. The traditional students did not complete the SURE.

	Semester			
Measure	Start of 1st	End of 1st	End of 2nd	End of 4th
Science Self-Efficacy[1]	X	X	X	X
Science Identity[1]	X	X	X	X
Science Values Alignment[1]	X	X	X	X
Outcomes Expectations[2]	X	X	X	X
Science Career Interest[1]	X	X	X	X
Biology Motivation[5]	X	X	X	X
Ease of Transition[3, 4]		X	X	
Sense of Belonging[6]		X	X	X
Survey of Undergraduate Research Experiences[7]				X

Sources: 1 = Estrada et al 2011, 2 = adapted from Byars-Winston et al. 2016, 3 = Hurtado and Carter, 1997, Johnson et al 2007, 5 = Glynn et al. 2011, 6 = Johnson, et al. 2007, 7 = Lopatto 2004.

Analysis and Findings

In this section, the findings for the cohort that has completed the program will be presented. Not all goals and/or objectives can be fully addressed however, since this is a longitudinal study and findings related to graduate rates or persistence are still in the process of being collected and analyzed. The results will focus on the 1st cohort which has completed the RISEbio program.

Survey Instruments

At the end of the 1st semester students in the RISEbio program indicated a significantly easier transition ($F_{1, 33} = 8.0529$, $p = 0.0078$) and a higher sense of belonging compared ($F_{1, 31} = 4.6023$, $p = 0.0401$) to the traditional students. RISEbio students held significantly higher biology motivation at the start of their 1st semester ($F_{1, 56} = 33.3507$, $p < 0.0001$) which may not be surprising since students self-selected to apply and be part of the RISEbio program which may result in these students already having a higher initial motivation. However, this motivation also was observed at the end of their 1st semester ($F_{1, 31} = 26.2553$, $p<0.0001$) and through the end of their 2nd semester ($F_{1, 31} = 13.4715$, $p = 0.0009$). No other differences between the RISEbio and traditional students was found until the end of the 4th semester. At the end of the 4th semester, there were significant differences for student self-efficacy ($F_{1, 16} = 12.1063$, $p = 0.0034$), interest in pursuing a science related career ($F_{1, 16} = 9.4682$, $p = 0.0077$), science values ($F_{1, 16} = 7.8098$, $p = 0.0136$), and science identity ($F_{1, 16} – 7.4101$, $p = 0.0157$) with the RISEbio students responding higher on all scales than the traditional students. RISEbio self-efficacy was the only measure to significantly shift over the 4 semesters ($F_{3, 41} = 3.2598$, $p = 0.0319$) with the lowest self-efficacy found at the start of their 1st semester and the highest at end of their 4th semester. Conversely, motivation for the traditional students significantly decreased over the 4

semesters with the highest motivation being found at the beginning of the 1st semester ($F_{3, 94}$ = 4.2202, p = 0.0077).

Performance

For the first introductory biology sequence course, there was no difference in the percentage of final grades for RISEbio and traditional students but a difference in letter grade distribution was found (χ^2 [6, N = 159] = 22.476, p = 0.0010) with RISEbio students being more likely to earn an A (47%) than the comparison group (11%) and less likely to earn a D/F/W or drop the course (11%) compared to the traditional students (43%). The RISEbio students earned final percentage grade differed significantly in the second introductory biology sequence course compared to the traditional students ($F_{1, 160}$ = 4.4654, p = 0.0361). There was also a significant difference in the distribution of letter grades for this course (χ^2 [6, N = 95] = 26.405, p = 0.0002) with 64% of RISEbio students earning an A compared to 12% in the traditional group. RISEbio students were also less likely to earn a D/F/W or dropped the course at 7% compared to 42%.

Persistence in Program

Students who left the program (N=6) did so because they changed majors (N=4) or left the institution (N=2). These students had a significantly lower cumulative year 1 GPA compared to those who stayed (N=11) ($F_{1, 10}$ = 15.0628, p = 0.0022). However, there was no difference in student grades in their introductory biology courses or their responses on the survey instruments based on their likelihood to persist.

Contribution

Although, there is extensive research on persistence, academic success, student views and research initiatives in DBER, there are few studies that examine programs that have linked these components together. The RISEbio program also is unique because it was not developed and implemented at research intensive university where you typically find these programs. The RISEbio program instead, fits within the available infrastructure at a primarily undergraduate comprehensive institution. This program model provides a foundational framework that can be adapted and executed effectively at other similar institutions. Through the assessment of RISEbio and traditional students we have gained unique information about our 1st and 2nd year students and the importance of bridging social integration, mentorship and technical/professional skill development with an immersive research program. This program also has the potential to provide insight into how financial barriers may influence student success since the support of this program is through a scholarship-based grant and our focus is to primarily serve low-income students.

General Interest

The concern over student performance and attrition is of primary importance in DBER. The program and study outlined here provides an approach to help facilitate a shift in promoting persistence and academic success in biology. The design and program presented in this proposal are applicable and transferrable to many institutions and programs. The use of a research immersive program and social structures can be scaled up or down depending on the limitations and resources available. The program can also be utilized to fit the specific and unique issues that a program may be facing. For example, the RISEbio program was designed to bridge student experiences between the end of their freshman year and the beginning of their sophomore year as

our majors tend to have a high attrition rate during this point in their college career. The specifics of the RISEbio design could be context-dependent and allow programs to target the weaker areas of student progress while still utilizing our integrative model. In addition, this program template has the ability to expand into other programs beyond biology to help address success and persistence in other STEM fields.

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