



Variability in STEM Summer Bridge Programs: Associations with Belonging and STEM Self-Efficacy

Joan M. Barth^{1*}, Sarah T. Dunlap¹, Anneliese C. Bolland², Debra Moehle McCallum¹ and Viola L. Acoff³

¹Institute for Social Science Research, The University of Alabama, Tuscaloosa, AL, United States, ²Institute for Communication and Information Research, The University of Alabama, Tuscaloosa, AL, United States, ³College of Engineering, The University of Alabama, Tuscaloosa, AL, United States

OPEN ACCESS

Edited by:

Chris Botanga,
Chicago State University,
United States

Reviewed by:

Jacqueline Smith,
Bowie State University, United States
Kristy Mardis,
Chicago State University,
United States

Matthew Van Duzor,
North Park University, United States
Myron W. Jones,
Southern Illinois University
Edwardsville, United States

*Correspondence:

Joan M. Barth
jbarth@ua.edu

Specialty section:

This article was submitted to
STEM Education,
a section of the journal
Frontiers in Education

Received: 13 February 2021

Accepted: 18 May 2021

Published: 21 June 2021

Citation:

Barth JM, Dunlap ST, Bolland AC,
McCallum DM and Acoff VL (2021)
Variability in STEM Summer Bridge
Programs: Associations with
Belonging and STEM Self-Efficacy.
Front. Educ. 6:667589.
doi: 10.3389/feduc.2021.667589

To address the challenges facing racial minority students majoring in STEM during the transition from high school to college, NSF funded Louis Stokes Alliances for Minority Participation (LSAMP) programs throughout the country implement summer bridge programs. Bridge programs vary in their focus on professional development, academic support, research experiences, social activities, and in other areas, but all share an intention to support students during their transition to college. Beyond retention, little is known about how these varied summer bridge experiences impact student outcomes in the first year of college. This study first describes the variability in the summer bridge programs in the Alabama LSAMP Alliance and then examines how differences in students' satisfaction with their experiences are associated with feelings of belonging and STEM self-efficacy, two factors associated with STEM retention. Students ($N = 145$) who attended an LSAMP summer bridge program were surveyed at three time points over the first year of college. Findings indicated that bridge programs varied in their offering of academic classes, academic support (e.g., study skills), research experiences, professional development, and planned social activities. Students attending HBCUs scored more favorably than students at PWIs on some measures; however, these differences could be accounted for by satisfaction with bridge experiences. Satisfaction with specific aspects of the bridge programs, especially orientation activities and getting to know other students, were associated with feelings of belonging and STEM self-efficacy. These relations were stronger for belonging. Over the course of the academic year, the relations between bridge satisfaction and belonging and self-efficacy weakened.

Keywords: LSAMP, summer bridge, stem majors, belonging, self-efficacy, college retention

INTRODUCTION

The special challenges facing racial minority students majoring in STEM during the first year of college are well documented and include poor academic preparation, difficulty with social and academic integration, lack of disciplinary socialization, and racial discrimination (Carlone and Johnson, 2007; Carter et al., 2009; National Research Council, 2011). To address these challenges, Louis Stokes Alliances for Minority Participation (LSAMP) programs throughout the country have implemented best-practice strategies and high impact activities, such as summer bridge programs, to retain students in STEM (Clewell et al., 2006; National Research Council, 2011). The primary

objective of this study is to examine how students' perceptions of summer bridge programs are related to belonging and STEM self-efficacy, two psycho-social characteristics associated with retention in STEM majors. A secondary objective is to illustrate the breadth of offerings and focus of successful summer bridge programs, which we hope will help other LSAMP alliances in creating summer programs.

Summer bridge programs are important because they are often the first point of contact between students and a higher education institution, major faculty, and collegiate peer group. Although broadly designed to improve retention, the specific objectives of summer bridge programs are far ranging and vary considerably:

“Summer programs that include or target minority middle and high school and undergraduate students provide experiences that stimulate interest in these fields through study, hands-on research, and the development of a cadre of students who support each other in their interests (p. 10, National Research Council, 2011)”.

“Bridge programs are designed to address the personal and inhibiting institutional factors of undergraduate students as they transition into college and have been suggested to increase academic readiness, promote inclusion and integration into the college academic and social community, introduce the students to available supportive institutional academic support programs and services, and promote self-efficacy and persistence (p. 36 Grace-Odeleye and Santiago, 2019)”.

As cases in point, the Challenge Program at Georgia Tech described by Murphy et al. (2010) consisted primarily of structured academic courses and a family support program. In contrast, an LSAMP program in Tennessee described by Howard and Sharpe (2019) had eight objectives that included academic course preparation, as well as objectives related to research experiences, motivation, and careers. This variability is also reflected in the Alabama LSAMP Alliance, which is the focus of the current research. One objective of this study is to describe the variation in the bridge programs at the nine campuses in this alliance, all of which were highly successful in the retention of students in STEM majors in the first year. The description serves as a resource for other programs considering a STEM bridge program for students from underrepresented racial groups.

Despite their variability, Clewell et al. (2006) note that LSAMP summer bridge programs share in common two characteristics, the integration of students into academic institutions and the socialization of students into their STEM profession. Thus, rather than focusing on retention, this study focuses on how students' experiences in summer bridge programs are related to two social psychological factors, belonging and STEM self-efficacy, that are associated with institutional integration, professional socialization, and retention over the course of the first year of college. Belonging refers to a sense of fit, identity, and support in a major (e.g., Walton and Cohen, 2007) and at a campus. Self-efficacy is a student's confidence that he or she has the necessary academic skills to pursue his or her major (e.g., Bong and Skaalvik, 2003).

This is an improvement over past studies of LSAMP programs, which have primarily considered retention and academic performance indicators (e.g., Howard and Sharpe, 2019). It is also important to consider that the adjustment tasks for first year students change over the course of the academic year as the challenge of academic classes increase. For these reasons, this study examined how students' perceptions of the summer bridge program are related to their sense of belonging and STEM self-efficacy at three time points over the first year of college: at the start of the fall term, the start of the spring term, and the end of the first year.

It is important to note that participants in the Alabama LSAMP program met and often exceeded institutional requirements for admission. For example, to receive an LSAMP scholarship, students must have a minimum 3.0 GPA and plan to major in a STEM field. As such, they would not be identified as at risk for dropping out solely based on their academic background. For this reason, this study focuses on factors associated with retention within a STEM major, rather than just retention in college.

Theoretical Foundations

Arnett's (2000) theory of emerging adulthood identifies the college years as a period when individuals make critical decisions about marriage, careers, and childbearing. Although college students have taken great steps toward independence, their lack of experience and financial dependence makes this time period both one of vulnerability and rapid personal growth. At a time when parents, teachers, and friends are less available for support, college students choose a major and career path. Eccles' stage-environment fit model (Eccles, 2004) proposes that school transitions will have a negative impact on academic outcomes when there is incongruity between a student's needs and the social context of schools. College adjustment is often difficult because, compared to high school, classrooms are less personal with little opportunity to develop relationships with classmates and instructors. These problems are even greater when students are faced with large introductory STEM classes. In college, competition is more intense and expectations for autonomy and independence are greatly increased. These issues are often more challenging for students from underrepresented racial groups due to negative racial stereotypes and a lack of same-race peers, faculty, and role models (Carter et al., 2009; Grace-Odeleye and Santiago, 2019). LSAMP bridge programs are designed to ameliorate some of the stress of the immediate transition and guide students to successful completion of a STEM degree. In theoretical terms, they are designed to “fit” the needs of racial minority students as they embark on a STEM degree path.

A contribution of this study is its focus on the transition to college over the first year. Little attention has been given to the impact of summer bridge programs and the variation in students' experiences within these programs on the immediate transition to college and subsequent adjustment throughout the academic year. Both the emerging adulthood perspective and the stage-environment fit model suggest that the needs of students immediately after they come to campus will be different from those later in the semester. Little attention has been paid to how variation in students' experiences within these programs affects adjustment to college

throughout the first year. Students' experiences and priorities during the first week of college are different from those at mid-term and the end of the academic year. Finding friends and a social niche give way to keeping up with coursework and stressing over exams. Career aspirations may take a backseat to the immediate challenges of surviving the first year of college. Bridge programs that focus on post-graduate opportunities at the expense of academic preparation and campus orientation may not meet the needs of students. Similarly, programs that include a research experience may promote students' STEM identity (Estrada et al., 2018), yet if students do not have the technical skills or enough disciplinary content knowledge to fully understand the project, their STEM self-efficacy and belonging may decline at the start of college. Importantly, because students who enter the LSAMP program vary in their background knowledge of their major and preparation, the same experience may impact students differently. For this reason, in this study the focus is on students' perceptions of their bridge experiences.

The choice to study STEM self-efficacy and belonging is motivated by numerous models of academic achievement and retention, some of which have focused on issues related to student race and ethnicity (e.g., Tinto, 1987; Wigfield and Eccles, 2000; Bandura et al., 2001; Lent et al., 2005; Hurtado et al., 2009). Although sometimes the labels change, most models identify academic self-efficacy and belonging as key factors in academic success. Self-efficacy has been found to be especially vulnerable during transitions at earlier time points in schooling (Eccles et al., 1993). Importantly, although STEM self-efficacy and belonging are often hypothesized to be related to success of programs targeting students in underrepresented racial groups (Lent et al., 2005; Carlone and Johnson, 2007; Hurtado et al., 2009), there is limited quantitative empirical research supporting these claims. (See Lent et al., 2005 for an exception.) This study seeks to fill this gap.

Self-Efficacy

Independent of one's actual abilities, self-efficacy is a judgment of the probability of success at a task in an academic field, a vocation, etc. (Bandura et al., 2001; Bong and Skaalvik, 2003). Championed by Albert Bandura in his social cognitive theory, self-efficacy plays a critical role in achievement in that there is little incentive for people to take on academic tasks or persevere in the face of challenges unless they believe that their actions will lead them to success (Bandura et al., 2001; MacPhee et al., 2013). A great deal of research indicates that the perceptions of one's ability are better predictors of persistence and interest in an academic area than actual ability (Bandura et al., 2001). For example, even when men and women perform the same academically in math (as indexed by GPA, coursework, etc.), women tend to underestimate their abilities, whereas men do not, and this underestimation leads to women's eventual departure from STEM (Correll, 2001; Hill et al., 2010). LSAMP programs provide mentoring, emotional support, modeling, and guidance, all of which can be instrumental in promoting self-efficacy (Cabrera et al., 2013). MacPhee and colleagues (2013), for example, found in their study of STEM majors participating in a McNair program that women were initially lower than men in self-efficacy, but after completing the two-year mentoring program, self-efficacy ratings improved such that women were on par with men.

Belonging

It is critical for college retention that students feel integrated into the larger campus setting and identify themselves as members of the larger college community (Tinto, 1987; Clewell et al., 2006). Belonging also describes students' feeling of fit with the culture of STEM (Cheryan et al., 2009; Cheryan et al., 2015) and their identity with a STEM profession. Campus integration and professional identity are both important for the retention of students and often more challenging for underrepresented racial groups (Walton and Cohen, 2011). First generation, minority, and low-income college students do not have access to the same information and resources as White and more privileged peers, making it more difficult to understand the college culture and expectations. Racial stereotyping and the stigma of being in a special program for racial minorities can create problems fitting in with a discipline and the larger campus at predominantly White institutions (PWI; Hurtado et al., 2009; National Research Council, 2011; Walton and Cohen, 2011). Programs such as LSAMP might succeed due to their ability to socialize students into the professional STEM culture, helping them to internalize a professional identity and to build solidarity with other professionals. In this study, we examine three components of belonging: how well students feel that they fit in with LSAMP programs and the larger campus (Cameron, 2004), STEM identity (commitment to, and desire for high performance in STEM; Chang et al., 2011), and the degree to which students feel supported by faculty at their institution.

The Current Study

There are two aims to this study. The primary objective is to examine how students' perceptions of summer bridge program elements are related to belonging and self-efficacy over the course of the first year of college. Prior to addressing this objective, we describe the nine LSAMP bridge programs in the Alabama Alliance, all of which had nearly 100% college and STEM major retention over the first year. A comparison of the degree to which each program provided structured activities associated with best practices for STEM retention is offered to serve as a resource to other LSAMP programs in creating summer programs. Importantly, a bridge activity label provided by a campus director may not fully capture informal interactions during the program nor describe the depth and breadth of these activities. For example, faculty mentoring might occur in any activity where faculty are present, even if an activity is not specifically labeled as such. For that reason, we focus on student satisfaction with a common set of six experiences (academics, campus orientation, getting to know other students, research, professional development, and faculty mentoring) and how satisfaction is related to belonging and STEM self-efficacy. Examining these relations over the first year of college provides insight into the lasting impact of summer bridge programs.

METHOD

Sample

The nine campuses in the Alabama State alliance included five comprehensive state public institutions, one of which was an

HBCU. The other four were private minority serving institutions (i.e., HBCUs). The racial make-up of the institutions varied from nearly 100% underrepresented racial groups at the HBCUs to a range of 25%–43% at the PWIs. Statistics were not available for the percentage of racial minority students in STEM majors at each of the campuses. However, consistent with the national trends, we would expect their representation to be lower in STEM fields. In addition to the STEM bachelor's degrees offered at each institution, the five public campuses offered master's and doctoral degrees in STEM fields.

Similar to other LSAMP merit-based scholarship programs in the United States, a minimum high school GPA of 3.0 was established for entering freshman, and students had to meet any other admission criteria for the institution sponsoring the bridge program. All participants had to declare an intention to major in a STEM field. In bridge programs that required students to take academic summer school classes ($n = 3$), students must have maintained a 3.0 GPA in their summer classes to receive the scholarship for the upcoming academic term. In the first year and beyond, students had to maintain a 3.0 GPA and remain a STEM major to continue in the Alabama LSAMP Alliance. Participants in this study were students who attended a summer bridge program between 2017 and 2019 and completed at least one follow-up survey as described below ($N_s = 145, 128, \text{ and } 125$, for the fall, early spring, and late spring time points, respectively). The group was 54.1% male and predominantly Black or African American (82.8%). Other racial groups represented included Hispanic or Latino (6.6%) and multi-racial (10.6%). Students provided their current major at each time point during the first year. The most recent major provided by students indicated the following percentages: 38% Engineering, 25% Biology and related fields (e.g., pre-Med), 19% Computer Science, 7% Biochemistry, 3% Chemistry, 2% Physics/Astronomy, 2% Mathematics, and 5% indicated another field.

A power analysis was conducted to assess the sample size needed to detect a medium effect size, with $\alpha = 0.05$ and power $(1 - \beta) = 0.80$, and six predictors in the regression equation using G Power (Faul et al., 2009). A sample size of 90 would be able to detect a medium effect size ($f^2 = 0.17$). This sample size is met or exceeded in the analyses.

Procedure

Prior to collecting data, the project was reviewed and approved by the Institutional Review Board at the authors' institution. Signed consent was obtained from students at the beginning of the summer bridge program. Campus directors at each institution provided the investigators with a schedule or syllabus for their summer bridge programs. Additional information was culled from campus reports provided each semester. The length of the bridge program and number of participants each year were noted. The activities listed in the schedules were reviewed by the investigators and categorized as described in the results section. The frequency and amount of time dedicated to an activity were noted.

Students completed surveys at the beginning of the fall term, early in the spring term (focusing on the previous fall semester), and late in the spring term at the end of the academic year

(focusing on the spring semester). Survey items included in this study are available in the online supplement. Surveys were completed online for the first two time points, but at the last time point students completed the survey either online or in person at the spring student conference if they were in attendance. Students were paid \$10 for each survey they completed. Surveys at each time point included several measures related to perceived academic abilities, belonging, support, STEM identity, and commitment to their major. Before the start of each survey, participants were reminded of their rights as research participants, including that their participation was voluntary, their answers were confidential, and they could withdraw at any time.

Survey Measures

Commitment to major was assessed at the beginning of the fall and spring terms. Students indicated their commitment on a 7-point scale (7 = very committed, 4 = unsure, and 1 = not at all committed). At the third time point, students were asked how likely they were to change their major on a 7-point scale in which higher scores indicated greater likelihood of changing their major. At each time point, students who were considering changing their major indicated the new major (open-ended response).

Belonging was assessed with three measures, belonging to college/program, STEM identity, and faculty support. *Belonging* to the college and the LSAMP program were measured by eight items. Six items were related to belonging to the college (e.g., *I feel I have a sense of belonging to this college/university; I have a lot in common with other students on campus*) taken from Cameron's (2004) measure of in-group ties. Two additional items were author generated and related to belonging to the LSAMP program at their institution (*I feel like I have a lot in common with the other LSAMP students on campus; I feel a connection with the other LSAMP students on campus*). Items were rated on a 7-point scale (1 = strongly disagree to 7 = strongly agree). Reliability of the scale was high with α ranging from 0.89 – 0.91 across the three time points.

STEM identity was assessed using four items adapted from the Chang, Eagan, Lin, and Hurtado (2011; also see Espinosa, 2011) measure for biomedical and biological science majors. Students rated the importance of having a successful career, making a theoretical contribution, getting recognition from colleagues in their STEM field, and making a contribution that benefits society. The latter item replaced the Chang et al. item concerning finding a cure to a health problem. The desire to benefit society was substituted because of its similarity to the original item and due to findings that women and students in underrepresented racial groups often pursue STEM to help others (Carlone and Johnson, 2007; Thoman et al., 2015). Items were rated on a 4-point scale with higher scores indicating greater importance. Reliability of the scale was sufficient, with α ranging from 0.60–0.75.

Faculty support was measured by three items adapted from the Lubben et al. (2006) measure of social support. Students indicated how many faculty (none, one, two, three to four; five to eight, nine or more) they knew who they could call on for help; could talk to about private matters; could ask for help with a course or

homework. Reliability of the scale was acceptable, with α ranging from 0.75–0.79 over the three time points.

As might be expected, the belonging to campus/LSAMP score was significantly correlated with the STEM identity and faculty support scores at each time point. Thus, to simplify the presentation of the results, the three scales were combined at each time point to create a Total Belonging score. Because the measures used different rating scales (4-point, 7-point and 9-point), scores were transformed to Z-scores and then averaged within each time point. Reliability of the combined measures was high, with α ranging between 0.87 and 0.88 across the three time points, further supporting this strategy.

Self-Efficacy for STEM academic performance was assessed by three items modeled after a measure developed by Lent et al. (2005), *How confident are you that you have the [math, science, spatial] skills necessary for your major?* Students responded using a 7-point scale (1 = no confidence and 7 = complete confidence). Responses were averaged to create a STEM Self-Efficacy score. Reliability was high, with α ranging from 0.81–0.86 across each time point.

Summer bridge satisfaction was assessed at the beginning of the fall term after all summer bridge programs were completed and included six questions focusing on students' satisfaction with specific aspects of the bridge program. The specific aspects of the summer bridge program included getting involved in research, professional development (presentations on careers in STEM, networking skills, resumes), academics (classes, refresher courses, study skills), orientation to the campus/program, getting to know other LSAMP students, and faculty mentoring/advising. Examples of each type of activity were provided. Students rated how well they thought each topic was covered during the bridge program on a 7-point scale (1 = not at all to 7 = very well). Mean satisfaction scores across the campuses indicated students generally had a positive view of the bridge programs, ranging between 5.18 ($SD = 1.81$) for Research and 5.81 ($SD = 1.52$) for Getting to Know LSAMP Scholars. Responses were also highly correlated (range 0.319–0.743, Median $r = 0.515$). Thus, a Total Satisfaction score was also created by averaging responses across the six items. Coefficient alpha for Total Satisfaction was 0.86.

RESULTS

Analytical Approach for Quantitative Measures

Data have a nested structure in that students belong to one of nine institutions. Typically, this would lead to using statistical techniques, such as multilevel or hierarchical linear modeling (MLM, HLM), to take into account the lack of independence of student data within each institution. However, after reviewing relevant statistical guides, including O'Dwyer and Parker (2014), Maas and Hox (2005), Raudenbush and Bryk (2002), and Scherbaum and Ferrerter (2009) this approach was deemed inappropriate for this study. Similar to all statistical procedures, the reliability of the results relies a great deal on sample size. In ordinary least squares (OLS) regression this

depends on the number of cases in the analysis. In HLM, rather than the number of individuals, reliability depends on the number of groups at the highest level in the model, which is nine (i.e., the number of institutions) in this study. O'Dwyer and Parker (2014) suggest that fewer than 20–25 groups may not provide accurate estimates of regression coefficients. Maas and Hox (2005) ran several simulations and reported that a minimum of 50 groups with 20 individuals in each group are needed to avoid biased estimates. Scherbaum and Ferrerter (2009) summarized previous studies on power and sample sizes and noted recommendations varied from 20–50 level 2 groups, depending on whether slopes or intercepts were being estimated. We fail to meet any of these recommendations. As a result, we proceeded using regression analyses to address the main research questions.

It should be noted that the sample sizes for the survey measures vary over time due to students failing to complete all of the surveys. *T-tests* were conducted comparing those who completed each survey to those who did not complete the survey on common measures at the previous time points. None of these comparisons were significant, suggesting that the variation in the sample size over time was not systematically associated with responses on the surveys.

Description of LSAMP Summer Bridge Program and Commitment to Major

All bridge programs were held on campus and students generally stayed onsite in student housing. The number of students at each bridge site varied across the institutions and over time. At the low end were programs with five or fewer students and at the higher end were programs with eight or more students. The variability in size was a function of grant-imposed limits on funds available to each campus, recruitment of students, and the ability of students who were recruited to the LSAMP program to attend the summer bridge program.

There was considerable variability in the length of the bridge programs (Table 1). Three of the bridge programs ran concurrently with summer school, and students were enrolled in traditional summer school courses in addition to participating in other bridge activities. One of these ran all summer (~10 weeks), and the other two ran just one summer school session (~5 weeks). Three bridge programs were 10–12 days, and the remaining three were 5–7 days. Four of the programs ended only a short time before the fall term began. For the rest, there were several weeks between the end of the bridge program and when school started.

Table 1 provides a summary of the common characteristics of the summer bridge programs based on the review of schedules and semester reports. Most of these characteristics are identified as “best practices” for retaining students in STEM, including academic support, research activities, and professional development/career planning experiences (National Research Council, 2011). These activities are listed in Table 1 because there was considerable variability among the institutions in the degree to which these were included in their bridge programs.

TABLE 1 | Description of Summer Bridge Activities for Each Institution.

| Campus | Institution Type ^a | Bridge Length in Days | Academic Classes ^b | Academic Support ^c | Research ^d | Prof. Dev ^e | Planned Social ^f |
|--------|-------------------------------|-----------------------|-------------------------------|-------------------------------|-----------------------|------------------------|-----------------------------|
| 1 | HBCU Public | 11 | M | L-M | M-H | M | H |
| 2 | HBCU Private | 6 | L | H | L-M | H | L |
| 3 | HBCU Private | 12 | M | L | L-M | L | H |
| 4 | HBCU Private | 32 | H | M | L | H | L |
| 5 | HBCU Private | 4 | L | H | L-M | L | H |
| 6 | PWI Public | 35 | H | L-M | M | L-M | L |
| 7 | PWI Public | 70 | H | M | H | M | L-H |
| 8 | PWI Public | 12 | L-M | L-M | M-H | M | L-H |
| 9 | PWI Public | 5 | H | L | L | L | L |

Notes. H = high, M = middle, L = low. There was some variation across the years in the content presented at different campuses that resulted in two classifications for an institution.

^aAll public schools offered advanced degrees in STEM. Private schools did not offer advanced degrees in STEM.

^bAcademic Classes: High = summer school courses; Middle = daily review session on selected topics over 1–3 weeks; Low = none.

^cAcademic Support: High = several sessions (at least 4) and topics occurring throughout a week; Middle = 2–3 sessions; Low = 1 or no sessions offered.

^dResearch: High = students developed a research project and presented it during the program; or several hands-on research activities; Middle = lab tours and research talks; Low = none.

^eProfessional Development: High = two or more sessions; M = one session; L = none.

^fPlanned Social Activities: High = at least one scheduled activity; Low = none.

Not listed in **Table 1** is campus orientation, which all campuses included and had little variability. Orientation activities included campus tours, visits to or presentations from key non-academic support service centers (student services, campus safety) and welcoming remarks from administrators. Other activities not included in **Table 1** were idiosyncratic to specific campuses. These include community service activities, personal development (self-reflection activities), money management, and health education (HIV-AIDS). Additionally, time dedicated to faculty mentoring was not apparent in the summer bridge schedules, although during the academic year, faculty advising/mentoring meetings were common. These activities most likely occurred informally or in conjunction with other activities but were not singled out in the schedules. Next, a brief summary and comparison of the characteristics presented in **Table 1** is provided.

Most campuses (7 of 9) included *academic classes* in math or science. Traditional summer school classes were included in three programs (campuses 4, 6, and 7), in which students took two classes (usually a math and a required non-STEM course, such as English) offered in the regular summer school program. Academic review classes differed from summer school classes in that they were not credit bearing. These typically included math (typically algebra) and science (typically chemistry or biology). In **Table 1**, High = summer school courses; Middle = daily review sessions on selected topics over 1–3 weeks; Low = none.

Academic support included workshops and lectures on topics such as study skills, time management, and motivation. These offerings varied across institutions and the different years of the program. One campus (campus 4) primarily focused on these

skills, offering several sessions each day of the program. Most covered 2–3 topics over the course of the summer, however, two programs did not include any of these activities in their schedules. In **Table 1**, High = several sessions (at least 4) and topics occurring throughout a week; Middle = 2–3 sessions; Low = 1 or no sessions offered.

Research activities included tours of faculty labs, research-oriented talks, and hands-on research activities. Two institutions (campuses 1 and 7) required students to develop a research idea that was presented at the end of the bridge program. Two institutions (campuses 4 and 9) listed no formal exposure to research as indicated on their schedules. In **Table 1**, High = students developed a research project and presented it during the program or participated in several hands-on research activities; Middle = lab tours and research talks; Low = none.

Professional and career development activities were not a central part of any program, but six of the programs had at least one session in this area. Session topics included presentations by campus career service organizations, resume writing, and explorations of STEM careers. In **Table 1**, High = two or more sessions; Middle = one session; Low = none.

Although all programs offered time for students to socialize outside of the bridge program, some programs built *social activities* into the formal schedule. These included leisure activities such as visits to local shopping areas and attractions, recreational activities (e.g., bowling), and picnics. The offerings varied from year to year with only three schools (campuses 1, 3, and 5) reliably offering more than two such experiences each year. In **Table 1**, High = at least one scheduled activity; Low = none.

Considering the information provided in **Table 1** as a whole, it can be seen that each of the nine campuses provided a unique experience for their students. The distinctiveness of each campus bridge program was included in the Alabama Alliance LSAMP proposal to NSF to allow each site the flexibility to address what they considered the challenges for first year students on their campus, as well as the strengths of their STEM programs. The activities cataloged are also listed as best practices for STEM retention (National Research Council, 2011).

Despite the variability among the summer bridge programs, retention of students in the program was quite high (meeting GPA minimums and having a STEM major), at nearly 100% at the end of the first year according to annual reports. Discontent with a major and an intention to change a major, however, may precede a student actually taking action to officially change majors. Thus, we examined students' commitment to their STEM major at each time point during the first year. Mean responses to the commitment to major question (possible range 1–7, with higher scores indicating greater commitment) were quite high at the Early Fall and Early Spring time points, $M_s = 6.04, 6.01$ $SD_s = 1.13, 1.08$, respectively. Across the nine campuses mean commitment to major scores ranged from 5.6–7.0 for Early Fall, and 5.0–6.6 for Early Spring. A *t*-test comparison between the two time points was not significant, $t(116) = 0.31$, suggesting that generally commitment to major was stable over the fall term. At the Late Spring time point, students were asked to rate the likelihood that they would change their major and the mean score was 2.4, indicating a low likelihood of changing majors (where 1 = very unlikely 7 = very likely). Over the 3 years, 74 students who had attended a summer bridge program indicated an intention to change their major. However, within this group most ($n = 53$) indicated another STEM major as their alternate. Collectively, 89.4% of the summer bridge participants remained committed to a STEM major. Together, the evidence suggests that the summer bridge programs in the alliance were associated with high retention rates in STEM. We next turn to the association of satisfaction with the summer bridge program and the social psychological factors associated with Total Belonging and STEM Self-Efficacy.

Relation Between Satisfaction with the Summer Bridge Program and Total Belonging and STEM Self-Efficacy

Before presenting the analyses associated with this objective, it is important to consider that students from underrepresented racial groups who attend HBCUs experience different campus environments from those at PWIs, regardless of their major or attendance at a summer bridge program (Winkle-Wagner and McCoy, 2018). *T*-test comparisons between students attending the two types of institutions on the bridge satisfaction measures indicated that students at HBCUs were more satisfied than those at PWIs, with marginally significant differences for two satisfaction measures ($p < 0.10$ for Research and Professional Development) and significant differences for three measures ($p < 0.05$ for Academic Support, Orientation, and Faculty Mentoring). The difference for Getting to Know LSAMP Scholars was not

significant. Total Belonging was significantly higher at the Early Fall and Early Spring time points, and marginally significantly higher at the Late Spring time point for students at HBCUs compared to those at PWIs. However, STEM Self-Efficacy was only significantly higher for HBCUs at the Late Spring time point. As a result of these differences, in the regression analyses, a stepwise regression approach was taken to determine if the campus type accounted for any additional variance in Total Belonging or STEM Self-Efficacy after the bridge satisfaction measures were entered into the equation.

Correlations Between Bridge Satisfaction and Belonging and STEM Self-Efficacy

Correlations between the Bridge Satisfaction measures (assessed at the Early Fall time point) and Total Belonging and STEM Self-Efficacy measures at each time point are presented in **Table 2**. At the Early Fall time point, each satisfaction measure was significantly or marginally significantly correlated with Total Belonging and STEM Self-Efficacy. At the Early Spring time point, Academic Support, Orientation, Getting to Know LSAMP Scholars and Total Satisfaction were correlated with Total Belonging, but none of the bridge satisfaction measures were correlated with STEM Self-Efficacy. At the Late Spring time point, Total Belonging was correlated with Academic Support, Orientation, Getting to Know LSAMP Scholars, and Total Satisfaction. In contrast to the Early Spring time point, at this third time point, STEM Self-Efficacy was positively correlated with each of the bridge satisfaction measures, except Getting to Know LSAMP Scholars. It is interesting to note that satisfaction with Academic Support, Orientation, and Getting to Know LSAMP Scholars were most consistently related to Total Belonging and STEM Self-Efficacy over the first year.

Regression Analyses Predicting Total Belonging and STEM Self-Efficacy

The correlation analyses suggest that many aspects of the summer bridge programs have a positive impact on Total Belonging and STEM Self-Efficacy. Regression analyses were conducted to determine the combined impact of satisfaction with the summer bridge components on Total Belonging and STEM Self-Efficacy and to assess if attending an HBCU (over a PWI) accounted for variance on these two measures after taking into account the summer bridge experiences. Although it was highly desirable to assess if satisfaction with distinct components of the summer bridge program were differentially predictive of the outcomes, a challenge in these analyses was that the significant correlations among the bridge satisfaction measures could affect the reliability of the regression coefficients. Consequently, two sets of regressions were conducted. In the first set, Total Belonging and STEM Self-Efficacy at each time point were predicted by Total Bridge Satisfaction and HBCU vs. PWI status (HBCU = 1 and PWI = 0). Each of the predictors was entered in a stepwise manner, allowing for the assessment of the explanatory power of each (R^2 change). These analyses address whether attending an HBCU was associated with better outcomes after taking into account Total Satisfaction

TABLE 2 | Bridge Satisfaction Correlated with Total Belonging and STEM Self-Efficacy.

| Bridge Satisfaction | Early Fall N = 122 | | Early Spring N = 96-97 | | Late Spring N = 93 | |
|--------------------------------|--------------------|--------------------|------------------------|---------------|--------------------|---------------|
| | Total Belonging | Self-Efficacy | Total Belonging | Self-Efficacy | Total Belonging | Self-Efficacy |
| Involvement in Research | 0.247** | 0.229* | 0.139 | 0.029 | 0.147 | 0.254* |
| Professional Development | 0.190* | 0.230* | 0.143 | -0.012 | 0.104 | 0.268** |
| Academic Support | 0.237** | 0.160 ^m | 0.308** | 0.062 | 0.301** | 0.275** |
| Orientation to College | 0.407*** | 0.273** | 0.406** | 0.086 | 0.335*** | 0.224* |
| Getting to Know LSAMP Scholars | 0.361*** | 0.254** | 0.409*** | 0.167 | 0.216* | 0.122 |
| Faculty Mentoring/Advising | 0.297*** | 0.242** | 0.145 | 0.038 | 0.045 | 0.214* |
| Total Satisfaction | 0.378*** | 0.301*** | 0.338*** | 0.081 | 0.247* | 0.291** |

Note. The sample sizes for correlations with Professional Development are one less than the stated N due to incomplete data from one participant on this measure. * $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$ (2-tailed).

TABLE 3 | Regressions Predicting Total Belonging and STEM Self-Efficacy from Total Bridge Satisfaction.

| Predictors | Time 1 Early Fall | | Time 2 Early Spring | | Time 3 Late Spring | |
|---------------------------|-------------------|--------------------|---------------------|--------------------|--------------------|--------------------|
| | Total Belonging | STEM Self-Efficacy | Total Belonging | STEM Self-Efficacy | Total Belonging | STEM Self-Efficacy |
| Step 1 | | | | | | |
| Total Bridge Satisfaction | 0.378*** | 0.301*** | 0.338*** | 0.081 | 0.247* | 0.291** |
| R ² Change | 0.143*** | 0.090*** | 0.114*** | 0.007 | 0.061* | 0.085** |
| Step 2 | | | | | | |
| Total Bridge Satisfaction | 0.345*** | 0.281** | 0.296** | 0.057 | 0.232* | 0.274** |
| HBCU vs PWI | 0.121 | 0.074 | 0.124 | 0.071 | 0.047 | 0.064 |
| R ² Change | 0.014 | 0.005 | 0.013 | 0.004 | 0.002 | 0.004 |
| Total R ² | 0.157*** | 0.095** | 0.128** | 0.011 | 0.063 ^m | 0.089** |
| Total F | 11.07*** | 6.28** | 6.89** | 0.52 | 3.02 ^m | 4.38** |
| Total df | 2, 119 | 2, 119 | 2, 94 | 2, 93 | 2, 90 | 2, 90 |

Note. Entries for the satisfaction scores are standardized regression coefficients (beta). ^m $p < 0.10$; * $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$ (2-tailed).

TABLE 4 | Regressions Predicting Total Belonging from Bridge Satisfaction.

| Predictors | Time 1 Early Fall | | Time 2 Early Spring | | Time 3 Late Spring | |
|--------------------------------|-------------------|----------|---------------------|----------|--------------------|--------------------|
| | Step 1 | Step 2 | Step 1 | Step 2 | Step 1 | Step 2 |
| Bridge Satisfaction | | | | | | |
| Involvement in Research | 0.083 | 0.082 | -0.197 | -0.201 | 0.010 | 0.009 |
| Professional Development | -0.147 | -0.139 | -0.041 | -0.038 | -0.226 | -0.224 |
| Academic Support | -0.134 | -0.124 | 0.127 | 0.153 | 0.211 | 0.215 |
| Orientation to College | 0.381** | 0.350** | 0.305* | 0.238 | 0.296 ^m | 0.285 ^m |
| Getting to Know LSAMP Scholars | 0.204* | 0.215* | 0.324** | 0.347** | 0.116 | 0.119 |
| Faculty Mentoring/Advising | 0.157 | 0.139 | -0.034 | -0.067 | -0.085 | -0.089 |
| HBCU vs PWI | | 0.061 | | 0.135 | | 0.019 |
| R ² Change | 0.236*** | 0.003 | 0.255*** | 0.014 | 0.162* | <0.001 |
| Total R ² | | 0.238*** | | 0.270*** | | 0.163 |
| Model F | 5.85*** | 5.05*** | 5.09* | 4.64*** | 2.75* | 2.33* |
| Model df | 6, 114 | 7, 113 | 6, 89 | 7, 88 | 6, 85 | 7, 84 |

Note. Entries for the satisfaction scores are standardized regression coefficients (beta). ^m $p < 0.10$; * $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$ (2-tailed).

with the bridge program. These results are presented in **Table 3**. The second set of analyses was similar, except in the first step the six individual bridge satisfaction measures were entered. The R² change statistic in the first step indicates the collective amount of variance in Total Belonging or STEM Self-Efficacy explained by these measures. These analyses also allowed us to see if there are some bridge satisfaction components that were more important than others in predicting these outcomes. Because of the issue of multicollinearity, these results should

be considered cautiously. These results are presented in **Tables 4 and 5**.

The first set of regressions (**Table 3**) indicate that HBCU status did not significantly predict Total Belonging and STEM Self-Efficacy when Total Bridge Satisfaction was entered first in the analyses. With the exception of STEM Self-Efficacy at the Early Spring time point, Total Bridge Satisfaction was a significant or marginally significant predictor of the two outcome measures, with the variance explained ranging from 6% to 14% across the

TABLE 5 | Regressions Predicting STEM Self-Efficacy from Bridge Satisfaction.

| Predictors | Time 1 Early Fall | | Time 2 Early Spring | | Time 3 Late Spring | |
|--------------------------------|--------------------|--------|---------------------|--------|--------------------|--------|
| | Step 1 | Step 2 | Step 1 | Step 2 | Step 1 | Step 2 |
| Bridge Satisfaction | | | | | | |
| Involvement in Research | 0.069 | 0.068 | -0.051 | -0.053 | 0.062 | 0.059 |
| Professional Development | 0.079 | 0.086 | -0.099 | -0.097 | 0.071 | 0.080 |
| Academic Support | -0.187 | -0.177 | 0.059 | 0.074 | 0.173 | 0.184 |
| Orientation to College | 0.236 ^m | 0.207 | 0.037 | -0.003 | 0.006 | -0.030 |
| Getting to Know LSAMP Scholars | 0.147 | 0.157 | 0.169 | 0.181 | -0.080 | -0.069 |
| Faculty Mentoring/Advising | 0.081 | 0.065 | 0.021 | 0.001 | 0.108 | 0.095 |
| HBCU vs PWI | | 0.057 | | 0.080 | | 0.064 |
| R ² Change | 0.127* | 0.003 | 0.033 | 0.005 | 0.095 | 0.003 |
| Total R ² | | 0.129* | | 0.038 | | 0.098 |
| Model F | 2.76* | 2.40* | 0.51 | 0.50 | 1.48 | 1.30 |
| Model df | 6, 114 | 7, 113 | 6, 88 | 7, 87 | 6, 86 | 7, 85 |

Note. Entries for the satisfaction scores are standardized regression coefficients (beta). ^m $p < 0.10$; * $p \leq 0.05$ (2-tailed).

three time points. Neither Total Bridge Satisfaction nor HBCU vs. PWI status significantly predicted Early Spring STEM Self-Efficacy. Together, these findings suggest that students' experiences with the summer bridge program may affect both Belonging and STEM Self-Efficacy over the first year of college. The next set of analyses explores whether satisfaction with specific aspects of the summer bridge program accounts for these relations.

For Total Belonging (Table 4), the amount of variance explained by Bridge Satisfaction measures was significant at each of the three time points, but was higher for the two earlier time points compared to the third (24%, 26%, and 16%, respectively). The addition of HBCU status in the second step failed to produce a significant increase in R^2 at any of the time points. A closer look at the beta coefficients in Table 4 indicates that Orientation to College and Getting to Know LSAMP Scholars were the only significant predictors at Time 1 and 2, and there were no significant predictors at Time 3. The lack of significant predictors and the decline in variance explained at Time 3 suggests that over time the effects of the summer bridge program on belonging diminish.

For STEM Self-Efficacy (Table 5), the bridge satisfaction measures significantly predicted this outcome at Time 1, but not at any other time point (Table 5). Although the first step as a whole was significant, none of the individual Bridge Satisfaction scores were significant on their own. HBCU status did not contribute to the variance explained for any of the time points.

DISCUSSION

The objectives of this study were to describe a range of successful summer bridge programs and examine how student perceptions of different program components are associated with belonging and STEM self-efficacy. As illustrated in Table 1, the programs varied considerably across a number of dimensions. The length of the summer bridge programs varied from an entire summer to 4–5 days. Some programs placed a strong emphasis on preparing students for STEM academic work through summer classes or

review sessions. Those that did not offer these experiences instead emphasized providing academic support, such as study skills, time management, and motivation techniques (campuses 2 and 5). Hands on research or laboratory experiences were offered by three campuses (campuses 1, 7, and 8) and the others either offered laboratory tours or talks, or did not emphasize research at all. Despite this variability, satisfaction was high on all campuses, and once students entered the fall academic term, regardless of the content of the summer bridge program, they were very likely to maintain a minimum GPA of 3.0 and continue their pursuit of a STEM major.

It is important to note that each campus continued to offer programs to the LSAMP scholars throughout the academic year. Most had regular weekly or monthly meetings and provided opportunities for students to engage in research and professional development activities. All students were expected to attend the annual LSAMP conference toward the end of the spring term in which students presented research posters and attended talks and workshops. Thus, the success of the Alabama LSAMP program in retaining students cannot be attributed to the summer bridge experience alone. However, survey data collected early in the fall term before most of these other program elements had been implemented, suggests that the quality of student experiences in the summer bridge programs was related to important social psychological characteristics associated with persistence in STEM, especially during the first semester of college.

With respect to belonging, preliminary regression analyses indicated that Total Satisfaction with the summer bridge program was predictive of Total Belonging at each time point (Table 3). Additional regressions provided insight into how satisfaction with individual components of the bridge experience were related to Total Belonging at each time point. At the beginning of the fall term, student satisfaction with multiple elements of the summer bridge program was related to Total Belonging. Additional regression analyses allowed for the examination of the combined effects of the individual satisfaction measures and indicated a strong predictive relationship for Total Belonging, explaining up to

24% of the variance. Some caution must be taken in interpreting the *beta* coefficients in the regression models since the satisfaction measures are inter-correlated; however, the results suggest that satisfaction with Orientation and Getting to Know LSAMP Scholars may be the best predictors of belonging.

The second time point assessments took place after the first semester had ended. Correlations indicated that satisfaction with summer bridge Academic Support, Orientation, and Getting to Know LSAMP Scholars were still positively related to Total Belonging. Similar to the Early Fall time point, regression analyses indicated that satisfaction with the bridge experiences was highly predictive of Total Belonging, explaining up to 26% of the variance. Again, Orientation and Getting to Know LSAMP Scholars were more strongly associated with Total Belonging than the other bridge satisfaction measures. After HBCU status was entered at step 2 in the regressions, only Getting to Know LSAMP Scholars was significant.

At the end of the year, the pattern of correlations between Total Belonging and bridge satisfaction was similar to the second time point. Although the regression analysis was significant at the first step, the amount of variance explained was much less, about 16%.

Together these findings suggest that satisfaction with the summer bridge program had diminishing impact on feelings of belonging at the end of the first academic year. According to Eccles' stage-environment fit model (Eccles, 2004) this might be because bridge experiences are more attuned to helping students with the adjustment tasks at the beginning of the year (e.g., making friends, negotiating class schedules, and course expectations). Additionally, more recent experiences in the LSAMP program and on campus likely override experiences that occurred nine or more months earlier. As noted above, some caution must be taken in interpreting the *beta* coefficients in the models. However, in combination with the correlation results, they suggest that activities that help students orient to the college and provide a social bond among fellow LSAMP scholars might be especially important in creating a sense of belonging. Orientation activities may be effective because they reduce the anxiety associated with learning to negotiate a new living environment, such as finding classrooms and dorm life, as well as introducing students to key personnel and services (e.g., the registrar, financial aid, student health services). Developing social connections with other students is a key factor in student retention (Tinto, 1987; Walton and Cohen, 2011) and so it is not surprising that getting to know others is important. For STEM majors belonging to underrepresented racial groups, making these connections might be especially impactful (Walton and Cohen, 2011).

In contrast to belonging, the effects of satisfaction with the summer bridge program on STEM Self-Efficacy were less robust, explaining less variance compared to Total Belonging in nearly every analysis. Total Bridge Satisfaction (Table 3) was associated with STEM Self-Efficacy at the Early Fall and Late Spring time points, but the amount of variance explained was considerably less at the third (9%) than the first (14%) time point. When the components of Bridge Satisfaction were considered (Table 5), the overall regressions were only significant at the Early Fall time

point and none of the individual Bridge satisfaction regression coefficients were significant. Additionally, the amount of variance explained by the satisfaction measures collectively ($R^2 = 0.13$), was much less than that explained for Total Belonging at the same time point ($R^2 = 0.24$).

It is curious that Table 2 indicates that most of the summer bridge satisfaction measures were significantly correlated with STEM-Self-Efficacy at the Late Spring time point but were not individually significant in the regression analyses. This suggests that whatever accounts for these correlations is not independent across the bridge satisfaction measures, for example a generic positive feeling about the experience. Thus, there seems to be a cumulative or additive effect of these individual components. No one of them has a strong enough impact to produce a significant *beta*, but together the sum of their small impacts yields a significant R^2 . More research is needed to understand this phenomenon.

Why was Total Belonging more strongly related to the summer bridge experiences than STEM Self-Efficacy? One possibility is that feelings of belonging may be more readily affected by the current social environment. The Total Belonging measure consisted of several components: belonging to campus and LSAMP, STEM identity, and faculty support. These beliefs are likely susceptible to the new experiences and social relationships formed in the summer bridge program. Bridge programs may be more successful at intervening in these areas than in areas related to academic self-concept. Confidence in math, science, and spatial skills is likely the result of many years of school experience. The additional courses and review sessions offered by most of the campuses in our alliance may not strongly affect students' confidence in their abilities, especially when the students have been high achievers in their high schools prior to joining the program. On the other hand, it is possible that the bridge programs are effective in maintaining students' high STEM Self-Efficacy during the first year of college, a time when it might be expected to drop (Eccles, 2004). Additional research that includes a non-intervention comparison group would help to understand this result.

An interesting finding in this study was that the advantages that HBCUs have over PWIs in promoting a sense of belonging and STEM self-efficacy were lessened by students' participation in the summer bridge program. Although this study only examined a limited set of outcomes, this finding is encouraging because it suggests that PWIs that engage in practices similar to the summer bridge program may provide significant support to these students.

There are some caveats and limitations to the findings presented so far. This study examined a variety of summer bridge programs, but these are only a small representation of the possible instantiations of LSAMP summer bridge programs throughout the country. Furthermore, although the sample was highly representative of the participants for three years of the program, they may not be representative of students across the U.S. Finally, the results do not extend beyond the first year of college. However, there are already multiple studies showing the efficacy of bridge programs for long-term retention of STEM students, (e.g., Clewell et al., 2006; National Research Council, 2011) Nevertheless, one purpose of the study was to show the variety and scope of different successful bridge programs, and we have been successful in meeting the objective. However, future

research with a larger sample and a greater number of programs throughout the country is needed.

Several strengths must be noted as well. First, considering multiple time points throughout the first year provided a developmental perspective on the impacts of the summer bridge program. Not surprisingly, the effects are stronger for the first half of the school year compared to the end of the second semester. Second, this study considered two social psychological outcomes in the context of a program with a highly successful retention rate for STEM majors, rather than simply focusing on retention. Studying these factors may help researchers and educators understand why bridge programs are helpful to students. In this program, the promotion of feelings of belonging is identified as a possible explanatory factor.

In conclusion, this study contributes to the literature on best practices for the retention of students from underrepresented racial groups in STEM. It suggests that students' perceptions of summer bridge programs may be related to their future sense of belonging, and to a lesser degree, their STEM self-efficacy. Thus, beyond preparing students for the academic rigors of college, summer bridge programs may promote beliefs and attitudes that contribute to their success in their major.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation.

REFERENCES

- Arnett, J. J. (2000). Emerging Adulthood: A Theory of Development from the Late Teens through the Twenties. *Am. Psychol.* 55, 469–480. doi:10.1037/0003-066x.55.5.469
- Bandura, A., Barbaranelli, C., Caprara, G. V., and Pastorelli, C. (2001). Self-Efficacy Beliefs as Shapers of Children's Aspirations and Career Trajectories. *Child. Dev.* 72, 187–206. doi:10.1111/1467-8624.00273
- Bong, M., and Skaalvik, E. M. (2003). Academic Self-Concept and Self-Efficacy: How Different Are They Really?. *Educ. Psychol. Rev.* 15, 1–40. doi:10.1023/a:1021302408382
- Cabrera, N. L., Miner, D. D., and Milem, J. F. (2013). Can a Summer Bridge Program Impact First-Year Persistence and Performance?: A Case Study of the New Start Summer Program. *Res. High Educ.* 54, 481–498. doi:10.1007/s11162-013-9286-7
- Cameron, J. E. (2004). A Three-Factor Model of Social Identity. *Self and identity* 3, 239–262. doi:10.1080/13576500444000047
- Carlone, H. B., and Johnson, A. (2007). Understanding the Science Experiences of Successful Women of Color: Science Identity as an Analytic Lens. *J. Res. Sci. Teach.* 44 (8), 1187–1218. doi:10.1002/tea.20237
- Carter, F. D., Mandell, M., and Maton, K. I. (2009). The Influence of On-Campus, Academic Year Undergraduate Research on STEM Ph.D. Outcomes: Evidence from the Meyerhoff Scholarship Program. *Educ. Eval. Pol. Anal.* 31 (4), 441–462. doi:10.3102/0162373709348584
- Chang, M. J., Eagan, M. K., Lin, M. H., and Hurtado, S. (2011). Considering the Impact of Racial Stigmas and Science Identity: Persistence Among Biomedical and Behavioral Science Aspirants. *J. Higher Edu.* 82, 564–596. doi:10.1080/00221546.2011.11777218

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Institutional Review Board at the University of Alabama. The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

VA coordinated and managed the Alabama LSAMP Alliance. JB, SD, AB, and DM contributed to the conception and design of the study. JB and SD were primarily responsible for data collection. JB was chiefly responsible for writing the manuscript and conducting the analyses. SD, AB, and DM reviewed and approved the final version.

FUNDING

This project was supported by the National Science Foundation award #1619659 to James Dalton (Principal Investigator), Kevin Whitaker (Former Principal Investigator), VA (Co-Principal Investigator), and JB (Co-Principal Investigator).

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/feduc.2021.667589/full#supplementary-material>

- Cheryan, S., Master, A., and Meltzoff, A. N. (2015). Cultural Stereotypes as Gatekeepers: Increasing Girls' Interest in Computer Science and Engineering by Diversifying Stereotypes. *Front. Psychol.* 6, 49. doi:10.3389/fpsyg.2015.00049
- Cheryan, S., Plaut, V. C., Davies, P. G., and Steele, C. M. (2009). Ambient Belonging: How Stereotypical cues Impact Gender Participation in Computer Science. *J. Personal. Soc. Psychol.* 97, 1045–1060. doi:10.1037/a0016239
- Clewell, B. C., Consentino de Cohen, C., Tsui, L., and Deterding, N. (2006). *Revitalizing the Nation's Talent Pool in STEM*. Washington, D.C.: Urban Institute. doi:10.1037/e723012011-001
- Correll, S. J. (2001). Gender and the Career Choice Process: The Role of Biased Self-Assessments. *Am. J. Sociol.* 106, 1691–1730. doi:10.1086/321299
- Eccles, J. S. (2004). "Schools, Academic Motivation, and Stage-Environment Fit," in *Handbook of Adolescent Psychology*. Editors R. M. Lerner and L. Steinberg John Wiley Sons, 125–153.
- Eccles, J. S., Midgley, C., Wigfield, A., Buchanan, C. M., Reuman, D., Flanagan, C., et al. (1993). Development during Adolescence: The Impact of Stage-Environment Fit on Young Adolescents' Experiences in Schools and in Families. *Am. Psychol.* 48, 90–101. doi:10.1037/0003-066x.48.2.90
- Espinosa, L. (2011). Pipelines and Pathways: Women of Color in Undergraduate STEM Majors and the College Experiences that Contribute to Persistence. *Harv. Educ. Rev.* 81 (2), 209–241. doi:10.17763/haer.81.2.92315ww157656k3u
- Estrada, M., Hernandez, P. R., and Schultz, P. W. (2018). A Longitudinal Study of How Quality Mentorship and Research Experience Integrate Underrepresented Minorities into STEM Careers. *CBE—Life Sci. Edu.* 17 (1), 1–13. doi:10.1187/cbe.17-04-0066) ar9
- Paul, F., Erdfelder, E., Buchner, A., and Lang, A.-G. (2009). Statistical Power Analyses Using G*Power 3.1: Tests for Correlation and Regression Analyses. *Behav. Res. Methods* 41, 1149–1160. doi:10.3758/brm.41.4.1149
- Grace-Odeleye, B., and Santiago, J. (2019). A Review of Some Diverse Models of Summer Bridge Programs for First Generation and At-Risk College Students.

- Administrative Issues J. Connecting Educ. Pract. Res.* 9, 35–47. doi:10.5929/9.1.2
- Hill, C., Corbett, C., and St. Rose, A. (2010). *Why So Few? Women in Science, Technology, Engineering, and Mathematics*. Washington, DC: American Association of University Women.
- Howard, B. L., and Sharpe Jr., L. (2019). The Summer Bridge Program. *Interdisciplinary Studies in Edu.* 7, 20–23. doi:10.32674/jise.v7i2.1207
- Hurtado, S., Cabrera, N. L., Lin, M. H., Arellano, L., and Espinosa, L. L. (2009). Diversifying Science: Underrepresented Student Experiences in Structured Research Programs. *Res. High Educ.* 50, 189–214. doi:10.1007/s11162-008-9114-7
- Lent, R. W., Brown, S. D., Sheu, H.-B., Schmidt, J., Brenner, B. R., Gloster, C. S., et al. (2005). Social Cognitive Predictors of Academic Interests and Goals in Engineering: Utility for Women and Students at Historically Black Universities. *J. Couns. Psychol.* 52, 84–92. doi:10.1037/0022-0167.52.1.84
- Lubben, J., Blozik, E., Gillmann, G., Iliffe, S., von Renteln Kruse, W., Beck, J. C., et al. (2006). Performance of an Abbreviated Version of the Lubben Social Network Scale Among Three European Community-Dwelling Older Adult Populations. *The Gerontologist* 46, 503–513. doi:10.1093/geront/46.4.503
- Maas, C. J. M., and Hox, J. J. (2005). Sufficient Sample Sizes for Multilevel Modeling. *Methodology* 1, 86–92. doi:10.1027/1614-2241.1.3.86
- MacPhee, D., Farro, S., Farro, S., and Canetto, S. S. (2013). Academic Self-Efficacy and Performance of Underrepresented STEM Majors: Gender, Ethnic, and Social Class Patterns. *Analyses Soc. Issues Public Pol.* 13, 347–369. doi:10.1111/asap.12033
- Murphy, T. E., Gaughan, M., Hume, R., and Moore, S. G., Jr. (2010). College Graduation Rates for Minority Students in a Selective Technical university: Will Participation in a Summer Bridge Program Contribute to success?. *Educ. Eval. Pol. Anal.* 32, 70–83. doi:10.3102/0162373709360064
- National Research Council (2011). *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads*. Washington, DC: National Academies Press.
- O'Dwyer, L. M., and Parker, C. E. (2014). *A Primer for Analyzing Nested Data: Multilevel Modeling in SPSS Using an Example from a REL Study*. REL 2015-046. Washington DC: Regional Educational Laboratory Northeast & Islands.
- Raudenbush, S. W., and Bryk, A. S. (2002). *Hierarchical Linear Models: Applications and Data Analysis Methods*, Vol. 1. Thousand Oaks, CA: Sage Publications Inc.
- Scherbaum, C. A., and Ferrerter, J. M. (2009). Estimating Statistical Power and Required Sample Sizes for Organizational Research Using Multilevel Modeling. *Organizational Res. Methods* 12, 347–367. doi:10.1177/1094428107308906
- Thoman, D. B., Brown, E. R., Mason, A. Z., Harmsen, A. G., and Smith, J. L. (2015). The Role of Altruistic Values in Motivating Underrepresented Minority Students for Biomedicine. *BioScience* 65, 183–188. doi:10.1093/biosci/biu199
- Tinto, V. (1987). *Leaving College: Rethinking the Causes and Cures of Student Attrition*. Chicago: University of Chicago Press.
- Walton, G. M., and Cohen, G. L. (2011). A Brief Social-Belonging Intervention Improves Academic and Health Outcomes of Minority Students. *Science* 331, 1447–1451. doi:10.1126/science.1198364
- Walton, G. M., and Cohen, G. L. (2007). A Question of Belonging: Race, Social Fit, and Achievement. *J. Personal. Soc. Psychol.* 92, 82–96. doi:10.1037/0022-3514.92.1.82
- Wigfield, A., and Eccles, J. S. (2000). Expectancy-Value Theory of Achievement Motivation. *Contemp. Educ. Psychol.* 25, 68–81. doi:10.1006/ceps.1999.1015
- Winkle-Wagner, R., and McCoy, D. L. (2018). Feeling like an “Alien” or “Family”? Comparing Students and Faculty Experiences of Diversity in STEM Disciplines at a PWI and an HBCU. *Race Ethn. Edu.* 21, 593–606. doi:10.1080/13613324.2016.1248835

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2021 Barth, Dunlap, Bolland, McCallum and Acoff. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.