Articles

Factors for First-Year College Biology Students

Kathryn Goddard[1*], Dale Cameron[1], Carlita Favero[1], Jennifer King[1], and Simara Price[1]

[1]Department of Biology, Ursinus College, Collegeville, Pennsylvania 19426

*Corresponding Author kgoddard@ursinus.edu

Abstract: "January Undergraduate Move Ahead Program" (JUMP) uses winter break as an opportunity to prepare small groups of scholarship students with high financial need for the second semester of their first-year biology curriculum and a career in life science. A winter intersession program has challenges, but more importantly, benefits that distinguish it from summer bridge programs. We designed JUMP to help students build their skills to succeed in lecture and laboratory courses and strengthen their bond to the major and science careers. Thus far, 26 students have participated in JUMP: 73% were female, 54% were students of color (SOC), 62% were Pell grant recipients, and 42% were first-generation college students. Our analyses indicate that the program contributes to advancement to graduation. Scholars graduated at a statistically significantly higher rate in the life sciences than other students in the same cohorts (p= 0.007). Pell grant recipients graduated in the life sciences at a significantly higher rate than other Pell grant recipients (p= 0.009) The majority of the participants reported that JUMP made them more comfortable in the biology department and confident in themselves as scientists. JUMP is adaptable to other institutions seeking opportunities to mitigate conditions that put student success at risk.

Keywords: undergraduate; winter break; students of color; first-generation; Pell grant

Introduction

Most college students need a new skill set for college courses, especially in life science curricula. Some pre-college situations put students at high risk of attrition from life science majors particularly in the first year of college. Students who are particularly in need are students whose high schools lacked the resources to prepare them for a rigorous science curriculum. Low-income students are disproportionally represented in this group (Kuh et al. 2006; Engle &Tinto, 2008; Executive Office of the President, 2014) yet, enrollment of low-income students is increasing nationwide (Calahan et al., 2021). We developed a five-day intersession program called January Undergraduate Move Ahead Program (JUMP) to give high financial need scholarship students a "jump ahead" for their second semester first-year biology course and a career in the life sciences.

The high-need JUMP scholars included students who were members of other groups that may experience conditions that put them at risk of attrition from life science majors. First-generation college students are one group with additional barriers to success. The first year can be particularly difficult as they lack their parents' first-year college experiences as a model of what to expect (Padgett et al., 2012). Some first-generation college students struggle with how to advocate for themselves in both academic and extracurricular situations, and how to make use of tutoring and other university services (Collier & Morgan, 2008; Cataldi et al., 2018).

Students of color (SOC) are often first-generation and low-income college students (Adams & McBrayer, 2020). Once they reach campus, SOC often face stereotyping and prejudice. Many SOC feel isolated and are subjected to microaggressions in the classroom from both other students and faculty (Banks & Dohy, 2019; Adams & McBrayer, 2020).

Variations on a theme: the diversity of winter break programs

Some colleges and universities throughout the US have seized the opportunity to develop winter intersession programs (Marcus, 2019). Winter break programs for students starting college in the spring semester or transferring to a four-year institution (Galvez et al., 2014; Enriquez et al., 2017) are similar to summer bridge programs in that they prepare students for college life. Winter break programs for already-enrolled students are designed to increase student academic success (time management), build skills in a particular discipline (e.g., math skills), inform students about career preparation, or offer experiential learning. Langhoff & Enriquez, 2017) or research experience (Blake, et al., 2013).

Enriquez et al (2013) and Galvez et al., (2014) offer two examples of winter break programs whose outcomes have been evaluated but assessment of winter break program effectiveness is not nearly as thorough as the assessment of summer bridge programs (reviewed in Sablan, 2014; Ashley et al., 2017; Grace-Odeleye & Santiago, 2019; Bradford et al., 2021). Knowledge of winter break program specific benefits and pitfalls is clearly useful to other institutions interested in establishing such programs.

Summer bridge programs tend to focus on course content, orientation to campus, increasing social capital, and getting to know the faculty (Bradford et al., 2021). Winter break programs can be designed to focus on other knowledge and skill development that high school and Summer Bridge did not provide. JUMP focuses on building students' experimental design skills and other skills to prepare them for STEM careers. JUMP is adaptable to other institutions seeking opportunities to mitigate conditions that put student success at risk.

MATERIALS AND METHODS

JUMP: Preparing First-year Students for Second semester

Ursinus College is a liberal arts college in southeastern Pennsylvania, USA that enrolls approximately 1500 students. The JUMP scholars were all first-year students who intended to major in Biology, Biochemistry and Molecular Biology (BCMB), or Neuroscience. Each received a four-year scholarship plus the opportunity to participate in JUMP as part of a National Science Foundation (NSF) S-STEM grant. Thus far,

26 scholars participated: 73% were female, 54% were students of color (SOC), 62% were Pell grant recipients, and 42% were first-generation college students. Scholars were selected based on NSF criteria

(https://www.nsf.gov/pubs/2020/nsf20526/nsf20526.htm). In addition, students were selected who: (1) used high school academic resources such as teacher office hours, (2) reported in their interview that they were likely to attend JUMP and the other programs, and (3) did not have opportunities such as research experiences in university laboratories. Most scholars worked at a job during high school and signified the intention to work during college. The grades of the scholars their first biology course (BIO101 as described below) did not differ significantly from their peers at the p = 0.5 level (data not shown).

The Ursinus first-year life science course sequence starts with BIO101 *Ecology and Evolution* in the fall followed by BIO102 *Cell Biology* in the spring. Both courses meet for three hours a week of lecture for 15 weeks plus 1.5 hours of laboratory each week. JUMP prepares scholars for BIO102 laboratory in which students must incorporate laboratory equipment use into an experiment of their own design. Both courses require students to read and discuss primary and secondary literature-- a new and demanding experience for nearly all students.

Program Structure

The five-day program ran Tuesday through Friday in 2017-2019 in the week prior to the start of the spring semester (Table 1).

Recruitment of Scholars

All scholars were strongly encouraged to attend JUMP, but attendance was not mandatory. A $250 stipend was offered to every scholar to offset possible lost wages. We provided $24 a day for meals per scholar. There were nine participants in 2017, ten in 2018, and seven in 2019.

Recruitment of Faculty

Each autumn, four faculty were recruited to participate in the program. They were compensated at $25/hour to prepare for and participate in the program.

Recruitment of Teaching Assistant/Residence Life Assistant

A college-trained resident assistant was paid $400 total to act as laboratory teaching assistant and resident assistant (TA/RA) during the program. Interviewees were asked about the type of evening programs they would provide, and their personal approach to academic success. Duties included laboratory preparation, organizing group meals and regular RA duties of monitoring student well-being.

Table 1. JUMP Schedule.

<table>
<tr><th></th><th>Monday</th><th>Tuesday</th><th>Wednesday</th><th>Thursday</th><th>Friday</th></tr>
<tr><td>8:30-9:00 AM</td><td rowspan="8">Prior to Arrival:

Read Yeast Experiment protocol, Answer Questions</td><td>Breakfast Together</td><td>Breakfast Together</td><td>Breakfast Together</td><td>Breakfast Together</td></tr>
<tr><td>9:00-10:00 AM</td><td>Team Building</td><td>Continue Experiment</td><td rowspan="2">Field Trip to Museum</td><td>Tricks for Reading Textbooks</td></tr>
<tr><td>10:00-11:00 AM</td><td rowspan="2">Reading Primary Literature</td><td>Preparing for Internships, Jobs, Recommendations</td><td rowspan="2">Finish Experiment and Prepare Presentation</td></tr>
<tr><td>11:00 AM-Noon</td><td>Continue Experiment</td><td>Lunch Downtown</td></tr>
<tr><td>noon-1:00 PM</td><td>Lunch with Faculty</td><td>Lunch with Dean</td><td rowspan="5">Visit with Alums at Research Laboratory at University</td><td>Lunch with Faculty</td></tr>
<tr><td>1:00-2:00 PM</td><td>Lab Skills for Bio102 & Beyond</td><td>Reflection on Your Bio101 Study Skills</td><td>Reading the Primary Literature</td></tr>
<tr><td>2:00-3:00 PM</td><td rowspan="3">Start Yeast Experiment</td><td>Microsoft Excel ® Use in Bio102 with RA/TA</td><td>Scholars Presentations</td></tr>
<tr><td>3:00-4:00 PM</td><td>Panel Discussion with Older Students</td><td rowspan="2">Jeopardy Game-Questions to Prepare for BIO102</td></tr>
<tr><td>4:00 PM-5:00 PM</td><td>Finish experiments</td></tr>
<tr><td>5:00-7:00 PM</td><td>Dinner Together</td><td>Dinner Together</td><td>Dinner with Faculty and Other Scholars</td><td>Dinner Together</td><td></td></tr>
<tr><td>Evening</td><td>Read 1st Primary Lit. assignment</td><td>Movie with All in Dorm & Read 2nd Primary Lit. Assignment</td><td>Start 3rd Primary Lit. Assignment; Go to Movies</td><td>Finish 3rd Primary Lit. Assignment</td><td>Relax until Classes Start Wednesday</td></tr>
</table>

Program Elements

Scientific Skill Development and Science Identity

JUMP activities designed to help scholars develop laboratory skills and confidence in themselves as scientists included an open-ended experiment on optimal conditions for *Saccharomyces cerevisiae* (brewer's yeast) growth. We pointed out to the scholars that we would offer JUMP to all students if possible, and that they would be able to help their fellow students in lab in BIO102. Staff pre-tested the experiment to minimize student frustration with failed experiments. The experiments occupied a significant portion of the five days. After consulting the literature, the scholars formulated a hypothesis in groups of two-three to assess growth of *S. cerevisiae* under different conditions of pH, light, temperature, and other factors. They were provided with yeast cultures and instructed in measuring growth using a spectrophotometer (Spec 20). They were provided with materials and equipment (e.g., ultraviolet light source, incubators of various temperatures) to test their hypotheses. They did their own calculations for preparing solutions. They continued to develop their Microsoft Excel ® skills by analyzing their data. The scholars were instructed on how to give a PowerPoint presentation (e.g., graphic design, slide content). They gave a presentation on their experiment to the Biology Department faculty and other JUMP participants on the last day of JUMP (Table 1).

Learning Skills

Primary literature articles were read and reading skills were discussed. The scholars also met with older scholars and the RA who talked to them about well-informed course scheduling and other hints for STEM success.

Increasing Connection to the Department and Institution and Cohort Building

Some program elements were designed to foster cohort building and a sense of belonging to the department and institution. These elements are all identified as important in STEM success (e.g., Chickering & Gamsen, 1987; Kuh et al., 2006; Engel & Tinto, 2008; Tinto, 2017; Owolabi, 2018; Strayhorn, 2018, p.37). Activities to increase a sense of belonging in the department and the college included interacting with faculty at meals, bowling, and going to the cinema to see films that provided opportunities for discussion: *Hidden Figures* and *On the Basis of Sex*. They had lunch with a dean who encouraged them to apply for additional scholarships and grants. The scholars read sample recommendation letters written for students applying for professional school, graduate school, or jobs. They were asked to consider what they could do to build their own resumes and relationships with faculty to receive similar recommendations. The scholars visited a local university laboratory where Ursinus alumni scientists described their own journeys to research jobs. Activities that focused on cohort building included breakfast together, cooking dinner together, and evening games.

Results

Comparisons were made between the scholars who attended JUMP and other students enrolled in BIO102 regarding grades and retention. The comparison groups were students in the same courses who entered the college in the same years (2016-18) with the same expected graduation year (2020-22) including all first-year students in the course and certain subsets: first-generation college students, SOC students, and Pell grant students. The sample sizes of scholars who were simultaneously SOC, first-generation and/or Pell grant were too low (fewer than ten) to compare to the same group in the general student population.

Course Grade and Retention in BIO102

To determine if the scholars derived benefit from JUMP, average course grade of the JUMP scholars was compared to that of their peers through a Mann Whitney U test using SPSS. There was a trend toward JUMP scholars performing better than their peers, but there was no statistically significant difference between the JUMP scholars and the comparison groups listed immediately above at the p = 0.05 level (Table 2).

To measure retention through BIO102 the proportion of students successfully completing the course with a passing grade (A+ though D- grade vs. withdrew or F grade) among the scholars vs. their peers was also assessed. The scholars' rate of completion of BIO102 was 100% (no failures). Although this result indicated a trend toward the scholars performing better than their peers, this result was not statistically significantly different from the results of their peer groups (Table 2).

Table 2. Performance and Retention of JUMP Scholars and comparison groups in BIO102

Student Group	BIO102 Grade		Withdrawals and Failing Grades		Retention through BIO102	
JUMP	N=26	2.73±0.84	N= 26	0 W, 0 F	100%	26/26
All Others	N=407	2.60±0.95	N = 407	9 W, 9 F	95.6%	398/416
JUMP 1st Gen	N=11	2.58±1.00	N = 11	0 W, 0 F	100%	11/11
Other 1st Gen	N= 120	2.42± 0.97	N= 122	2 W, 5 F	94.3%	115/122
JUMP SOC	N=14	2.67±1.0	N= 14	0 W, 0 F	100%	14/14
Other SOC	N= 87	2.38±0.97	N= 88	1 W, 5 F	93.2%	82/88
JUMP Pell Grant	N=16	2.67±0.87	N= 16	0 W, 0 F	100%	16/16
Other Pell Grant	N= 71	2.47± 1.0	N = 71	2 W, 3 F	93%	66/71

Grade means ± standard deviation on 4.0-point scale, number of withdrawals (W) and failing (F) grades, and percent retention. There were no statistically significant differences between JUMP scholars and other groups.

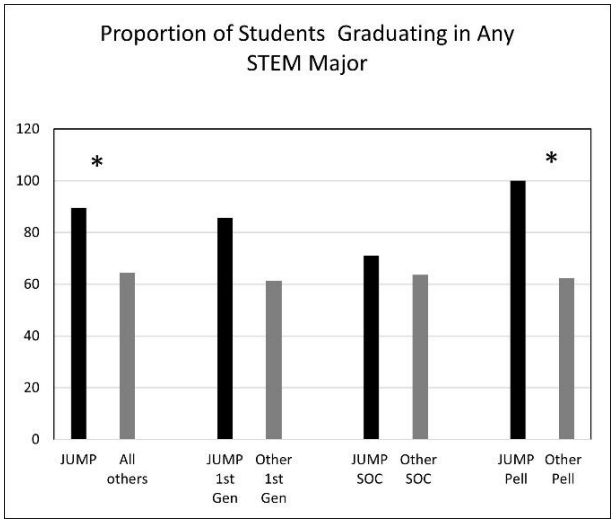
Retention to Graduation in Four Years

Retention to graduation was analyzed for the first two cohorts; the third cohort are seniors in the 2021-22 academic year. Students do not declare their major upon matriculation, therefore a method was devised to determine if first-year students who intended to major in the life sciences were retained to graduation in the life sciences. To that end, enrollment in BIO101 as a first-year undeclared science major was used to indicate that a student intended to major in a life science (Biology, BCMB, Environmental Studies, Health and Exercise Physiology, and Neuroscience) because enrollment in BIO101 is recommended to first-year students intending to pursue these majors and only these majors. Students who left the college or left the life sciences and graduated in a different major were counted as not retained in the life sciences. Some students who enrolled in BIO101 ultimately graduated in another major in the STEM division (chemistry, physics, or math and computer science) therefore a second comparison was made using all STEM graduates for a more conservative estimate of retention. Students who left the college or left the life sciences and graduated in a different major were counted as not retained in STEM.

The four-year graduation rate in the life sciences observed among the JUMP scholars (17/19) was statistically signficantly higher ($p = 0.007$) than that of other first year undeclared science students (N= 152/259) using a Fisher exact test (Figure 1). JUMP Pell grant scholars also graduated (N=10/10) at a significantly higher rate ($p = 0.009$) than other Pell grant students enrolled in BIO101 (N=22/40). The difference in graduation rates in the life sciences between the SOC students and between scholars who were first-generation college students (N=7) and other first-generation college students was not tested due to sample size in these groups.

Figure 1. Fisher Exact tests of the difference in retention to graduation between scholars and the general student population and the Pell eligible student subgroup.

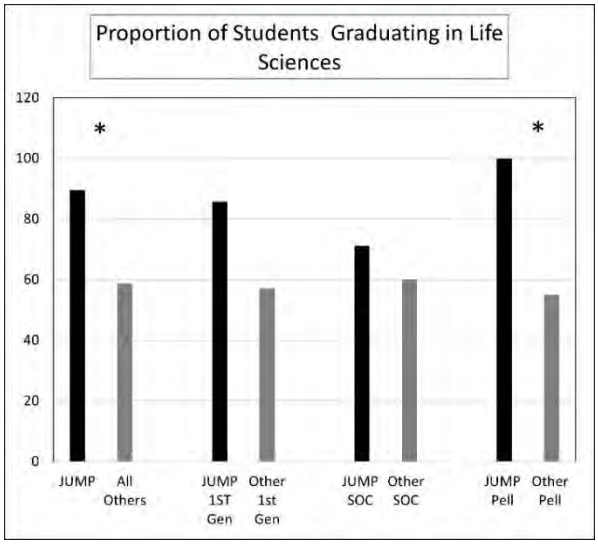
*Indicates data were statistically significant at the 0.05 level.



The first-generation and students of color data were not tested by a Fisher Exact test as the JUMP scholars' samples were fewer than ten scholars.

The four-year graduation rate in STEM observed among the JUMP scholars (17/19) was statistically signficantly higher ($p = 0.025$) than that of the general population of students who took BIO101 (N= 167/259) using a Fisher exact test (Figure 2). JUMP Pell grant scholars also graduated (N=10/10) at a significantly higher rate ($p = 0.022$) than other Pell grant students enrolled in BIO101 (N=25/40). The difference between the SOC scholars who graduated (N=7) in STEM and other first-generation college students was not tested due to sample size in these groups.

Figure 2. Fisher Exact tests of the difference in retention to graduation between scholars and the general student population and the Pell eligible student subgroup



*Indicates data were statistically significant at the 0.05 level. The first-generation and students of color data were not tested by a Fisher Exact test as the JUMP samples were fewer than ten scholars.

Scholar Perceptions of JUMP

Scholars completed anonymous surveys about the JUMP program immediately after the program, and after they completed BIO102 (Table 3 & 4). A Fisher exact test was used to test for change in responses between the first and second survey. The scholars reported that they had a positive experience in JUMP in the first survey. All respondents agreed or strongly agreed that formulating a hypothesis, practicing laboratory skills, and practicing calculations helped to prepare them for BIO102 and that they became better acquainted with other scholars (Table 3). Most agreed or strongly agreed that practice reading the primary literature and learning how to give a PowerPoint presentation were useful and that JUMP made them feel more at home in the Biology Department (where most life science faculty reside). We asked the scholars which academic and social activities to retain in the program for the following year. Over 75% of the scholars felt that the laboratory visit with alumni scientists, the science museum visit, lunch with faculty, and meals together should be retained in the program

Student survey responses about the JUMP program were again positive after they completed BIO102 (Table 4). There was a significant decrease in the proportion of scholars (4 of 22 scholars) who felt that JUMP gave them greater confidence in themselves in the major, which was statistically significant

using a Fisher exact test (p = 0.04). There were no other statistically significant differences using a Fisher exact test between the answers given immediately after JUMP and the answers given after BIO102. We asked the scholars which academic and social activities we should retain in the program in subsequent years in both the post-JUMP and the post-BIO102 survey. None of the differences in answers were statistically significant at the $p \leq 0.05$ level.

We considered other programs designed to increase student success in which students might enroll and the salutary effect of these programs on grades and retention. The other programs are tutoring, co-curricular program (skills building), intensive advising, and recitation (content reinforcement). No data is available on tutor use prior to Spring 2019. No scholars used tutors in Spring 2019. Of the

Table 3. Survey given at the end of the last day of JUMP to three cohorts of scholars who participated in the program.

Truncated Survey Questions	Strongly Agree	Agree	Disagree	Strongly Disagree	Total Responses
Formulating a hypothesis, a useful experience for BIO102	57.6%	42.3%	0.0%	0.0%	26
Lab skills good practice for BIO102	61.5%	38.4%	0.0%	0.0%	26
Practicing Lab calculations helped prepare me for BIO102	41.0%	58.8%	0.0%	0.0%	17
Practicing PowerPoint presentations useful	52.9%	41.1%	5.8%	0.0%	17
Lessons on primary literature reading useful for BIO102	42.3%	46.5%	11.5%	0.0%	26
JUMP made me feel more at home in Biology Dept.	61.5%	30.8%	7.9%	0.0%	26
JUMP made me more confident about my major	65.4%	34.6%	0.0%	0.0%	26
Stipend major motivation for participation	11.1%	66.7%	22.2%	0.0%	9
JUMP allowed me to get to know other scholars better	91.3%	8.6%	0.0%	0.0%	23

Nine scholars in 2017, ten scholars in 2018, and seven scholars in 2019 for a total of 26 participants. One scholar in 2018 did not complete the survey at all, and not all participants responded to all questions. The question about the stipend was asked only in 2018.

Table 4. Survey given in the fall following BIO102 to three cohorts of scholars

Truncated Survey Questions	Strongly Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Strongly Disagree	Total Responses
Formulating a hypothesis a useful experience for BIO102	63.6%	31.8%	4.5%	0.0%	0.0%	22
Lab skills good practice for BIO102	81.8%	9.1%	9.1%	0.0%	0.0%	22
Practicing Lab calculations helped prepare me for BIO102	68.2%	27.3%	4.5%	0.0%	0.0%	22
Practicing PowerPoint presentations	84.6%	7.7%	7.7%	0.0%	0.0%	13
Lessons on primary literature reading useful for BIO102	54.5%	36.3%	9.1%	0.0%	0.0%	22
JUMP made me feel more at home in Biology Dept.	63.6%	22.7%	13.6%	0.0%	0.0%	22
JUMP made me more confident about my major	59.0%	22.7%	18.1%	0.0%	0.0%	22
Stipend major motivation for participation	31.8%	31.8%	36.4%	0.0%	0.0%	22
Valuable to create a sense of community through JUMP	77.3%	18.2%	4.5%	0.0%	0.0%	22

Nine scholars responded in 2017, nine scholars in 2018, and four scholars responded in 2019 for a total of 22 responses. The Likert scale and the wording of one question were changed in the post-BIO102 survey for greater resolution of responses. The same two surveys were used in all three years.

scholars who attended JUMP, seven scholars out of the three cohorts fully attended (attended at least seven of the eight sessions) the co-curricular program. A total of 24 non-scholars fully attended the co-curricular program over the three-year period. Due to these low sample sizes, these data were not analyzed further. Records were not kept of student visits to office hours.

DISCUSSION

Course Grade and Retention in BIO102

The JUMP scholars succeeded in BIO102. Although there was a trend toward JUMP scholars earning higher grades and persisting through BIO102 at a higher rate than their peers, the differences between the JUMP scholars and their peers were not statistically significantly different, perhaps due to sample size in the scholar groups.

The JUMP scholars graduated at a statistically significantly higher rate than other life science majors and other STEM majors. While we cannot attribute this outcome solely to JUMP, it is apparent that JUMP is helping scholars to attain their academic goals. The aptitude and hard work of the scholars, even though many of them still worked at a job for 3-30 hours a week during college, was probably the strongest contributor to their success. We did not analyze the rate of advancement into science careers due to incomplete and constantly chasing information on graduates. Anecdotally, we note that of the scholars who have graduated, four were inducted in Phi Beta Kappa. Of the 18 graduates, two are seeking employment in STEM, one is accepted to veterinary school, one is applying to medical school, and the others are in graduate school, working for biotech firms, or government or university research labs.

Scholar Perceptions of JUMP

The scholars' own perceptions of the JUMP program were important evidence of the success and benefit of JUMP. The scholars' responses to the surveys indicated that they had a positive experience. Making students feel at home at their institution is important to their success (Kuh et al., 2006; Walton & Cohen, 2011; Owolabi, 2018) as well as their confidence in themselves as scientists (Carlone & Johnson, 2007; Cole, & Espinoza, 2008; Martin-Hensen, 2018). Four of the 22 scholars who reported feeling more confident of themselves as life science majors immediately after the JUMP program reported feeling less confident a few months later after completing BIO102. We take this result seriously; we have instituted a program through a second NSF grant to provide scholars with more academic support in their sophomore year.

Challenges of winter break programs

Some aspects of college winter breaks may require innovative solutions to carry out a JUMP-type program. A plan for meals must be made if the dining services are closed. Students may not have transportation to buy food, utensils to cook, or access to a dormitory kitchen, and it is difficult to make economic purchases of staples for five days. Issuing funds to students requires time-consuming bookkeeping for reimbursements. Eventually we supplied all meals every day to the students. It was efficient and effective at cohort-building.

Faculty buy-in is essential for any new program, including winter break programs. For institutions on a two semester (Fall-Spring) schedule, faculty may not be available for a winter break program (Galvez et al., 2014); January is a time for rejuvenation, family life, and preparation for the spring semester. Faculty compensation is helpful, but an interest in helping students to reach their full potential is a strong motivator.

Student safety on campus over winter break is a consideration. None of the JUMP scholars was alone on a dormitory floor during JUMP because athletes were on campus and a resident advisor was present. So that the scholars did not need to arrange and pay for transportation home and back to campus again, we allowed scholars to stay on campus through the weekend after the program until the semester began. Student health is also a consideration- we informed the scholars far in advance that the college wellness facility was closed in winter so that scholars could make other arrangements for health care or opt out of JUMP.

Benefits of winter break programs

Winter break provides an opportunity to focus on scientific skills and science identity rather than orientation to campus and other topics common to summer bridge programs. An advantage of winter break programs, no matter what the pedagogical content might be, is that they keep students intellectually engaged during a long period of academic inactivity. Loss of discipline-specific skills has been shown to occur over long breaks from academic pursuits (Van de Sande & Reiser, 2018). We were concerned that it would be difficult to convince students to return to campus in the last few days of winter break. On the contrary, by the third week of the winter vacation, students were ready to return to campus. Further, winter break programs can take advantage of local scientific resources, especially those that that are inaccessible during the semester due to students' course schedule constraints.

The JUMP program at Ursinus College has a positive impact on scholars: they feel comfortable in the Biology Department and confident about themselves as science majors. Other institutions could use winter break to develop JUMP-type programs that provide opportunities for small groups of students to work closely with faculty and other staff to address the specific needs of the students. Ursinus College will continue this program in the coming years. We are looking forward to inviting a wider variety of students to participate.

Acknowledgements

The National Science Foundation Directorate for Education and Human Resources Division of Undergraduate Education supported the work described here through NSF Award # 1458719 entitled “Supporting Inclusive Excellence in Biology, Biochemistry, and Neuroscience”. We thank Dr. Rebecca Kohn for her central role in writing the grant proposal, Ann Breen for her assistance in the laboratory, Dr. Timothy Stalker for arranging visits to the research laboratories at the Perelman School of Medicine, University of Pennsylvania, and Kevin Guidry Associate Director of Educational Assessment at the University of Delaware for his guidance. We are grateful to the Ursinus Institute for Institutional Research, Effectiveness, and the Ursinus Institute for Student Success for providing data. This study was approved by the Ursinus College Institutional Review Board under Project #RK-Dean-0312x.

REFERENCES

Adams, T.L., & McBrayer, J.S. (2020). The lived experiences of first-generation college students of color integrating into the institutional culture of a predominantly white institution. *The Qualitative Report, 25*(3): 733-756.

Ashley, M., Cooper, K.M., Cala, J.M., & Brownell, S.E. (2017). Building better bridges into STEM: A synthesis of 25 years of literature on STEM summer bridge programs. *CBE—Life Sciences Education,*

16(4): es3.

Banks, T., & Dohy, J. (2019). Mitigating barriers to persistence: A review of efforts to improve retention and graduation rates for students of color in higher education. *Higher Education Studies, 9*(1): 118-131.

Blake, R.A., Liou-Mark, J. & Chukuigwe, C. (2013). An effective model for enhancing underrepresented minority participation and success in geoscience undergraduate research. *Journal of Geoscience Education, 61*(4): 405-414.

Bradford, B.C., Beier, M.E. & Oswald, F.L. (2021). A meta-analysis of university STEM summer bridge program effectiveness. *CBE—Life Sciences Education, 20*(2) p.ar 21-14.

Cahalan, M.W., Addison, M., Brunt, N., Patel, P. R., & Perna, L.W. (2021). *Indicators of higher education equity in the United States:* 2021 historical trend report. http://pellinstitute.org/indicators.

Carlone, H.B., & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching, 44*(8): 1187-1218.

Cataldi, E.F., Bennnett, C.T., & Chen, X. (2018). *First-generation students: College access, persistence, and postbachelor's outcomes. Stats in brief.* NCES 2018-421. National Center for Education Statistics. https://files.eric.ed.gov/fulltext/ED580935.pdf.

Chickering, A.W., & Gamson, Z. F. (1987). Seven principles for good practice in undergraduate education. *AAHE bulletin, 3*:7.

Cole, D., & Espinosa, A. (2008). Examining the academic success of Latino students in science technology engineering and mathematics (STEM) majors. *Journal of College Student Development, 49*(4): 285-300.

Collier, P.J., & Morgan, D.I. (2008). "Is that paper really due today?" Differences in first-generation and traditional college students' understandings of faculty expectations. *Higher Education, 55*(4): 425-446.

Engle, J., & Tinto, V. (2008). *Moving beyond access: College success for low-income, first-generation students*.
http://www.pellinstitute.org/publications
Moving_Beyond_Access_2008.shtml.

Enriquez, A., Hum, D., Woo C., Price, B., Redding-Lapuz, D., & Camacho, A. (2013). Creating accelerated educational pathways for underprepared STEM students through an intensive math placement test review program. *Proceedings: 2013 American Society of Engineering Education PSW Conference*, 18-20.

Executive Office of the President. (2014). *Increasing College Opportunity for Low Income Students*
http://www.obamawhitehouse.gov/archives.

Galvez, G., Marinez, E., & Monge, A. (2014). HSI STEM: Research opportunities to improve retention an increase the pipeline to graduate school. *Proceedings: 2014 American Society of Engineering Education Zone IV Conference*, Long Beach, CA.

Grace-Odeleye, B., & Santiago, J. (2019). A review of some diverse models of summer bridge programs for first-generation and at-risk college students. *Administrative Issues Journal: Connecting Education, Practice, and Research 9*(1): 35-47.

Kuh, G.D., Kinzie, J.L., Buckley, J.A., Bridges, B.K., & Hayek, J.C. (2006). *What matters to student success*: A review of the literature (Vol. 8). Washington, DC: National Postsecondary Education Cooperative. https://nces.ed.gov/npec/pdf/Kuh_Team_Report.pdf.

Langhoff, N.P., & Enriquez, A.Z. (2017). *Development and Implementation of an Introduction to Research Winter Internship Program for Underrepresented Community College Students*. In 2017 ASEE Annual Conference & Exposition.

Marcus, J. (2019). *Some colleges start using their long winter breaks to help students plan for jobs*. http://www.hechingerreport.org/

Martin-Hansent, L. (2018). Examining ways to meaningfully support students in STEM. *International Journal of STEM Education, 5*(1): 1-6.

Owolabi, E. (2018). Improving student retention, engagement and belonging. *Lutheran Education Journal, 148* 58-72.

Padgett, R.D., Johnson, M.P., & Pascarell, E.T. (2012). First-generation undergraduate students and the impacts of the first year of college: Additional evidence. *Journal of College Student Development, 53*(2) 243-266.

Sablan, J.R. (2014). The challenge of summer bridge programs. *American Behavioral Scientist, 58*(8) 1035-1050.

Strayhorn, T.L. (2018). *College students' sense of belonging: A key to educational success for all students*. Routledge, New York

Tinto, V. (2017). Through the eyes of students. *Journal of College Student Retention: Research, Theory & Practice, 19*(3) 254-269.

Van De Sande, C. and Reiser, M. (2018). The Effect of Summer Break on Engineering Student Success in Calculus. *International Journal of Research in Education and Science, 4*(2): 349-357.

Walton, G.M., & Cohen, G.L. (2011). A brief social-belonging intervention improves academic and health outcomes of minority students. *Science, 331*(6023): 1447-1451.