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Summary of Outcomes from a Scientific Village Learning Community Implementation

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1.0 Introduction

Increasing the pipeline of underrepresented minority students into the STEM disciplines is a major priority for the US (Cullinane, 2009, Pender et. 2010, Estrada et al., 2016), and HBCUs (Gasman and Nguyen, 2014, Toldson 2018, and Toldson, 2019) represent a unique venue through which to reach a large population of such students. This research focused on increasing retention rates and improving academic and career success in the STEM disciplines at an open-enrollment HBCU through a hands-on and mentorship-focused research program. We have utilized the "Scientific Village" model, where students interacted as peers assisting, encouraging, holding each other accountable, and interacted with faculty mentors. Incorporating hands-on research further stimulated and engaged students to enhance interest in STEM curriculum and careers. This was a voluntary, three-year, mixed-method, hands-on research program that tracked a cohort of 60 second-semester STEM students at Benedict College. We conducted a mixed-methods study to examine the impact of a learning community model (the Benedict College Scientific Village), fused with critical pedagogy and hands-on laboratory research, on the collegiate success and retention of minority students in the STEM disciplines (Pantiwati, 2013). By introducing this model to students early in their college careers, we anticipated that various psychosocial and socio-economical impediments to student learning, retention, and academic success would be minimized. We confirmed that the Scientific Village model has a significant impact on the achievement, retention, and self-efficacy of STEM students at a small, historically Black college. The model and associated data can be transferred to the broader educational community and aid in recruiting, engaging, and retaining underrepresented minorities in STEM disciplines.

Through our mixed-method study, we have identified the key learning community factors that most influence student learning, retention, and academic success negating the psychosocial and socio-economic impediments generally observed in the student population to increase participation, retention, and graduation of minority students in the STEM disciplines (Mertens, 1998, Matthews, 2014). The project contributes to the prospect of developing strategic means of STEM education enhancement for under-represented minority students through hands-on research and participation in learning-community-based peer/mentor groups, leading to the development of critical thinking skills, creativity, self-confidence, and intellectual independence. With this project, we have presented data and pedagogical paradigms demonstrating that the "Scientific Village" model can be implemented with a relatively small change to current top-down approaches to instruction, resulting in substantially more engaged and successful students. Herein, we share with the STEM undergraduate education community the outcome of our study: how exposure to hands-on research coupled with the Scientific Village approach to learning enhanced the academic performance, retention, and graduation rate of minority STEM students.

This study focused on increasing retention rates and improving academic and career success in the STEM disciplines at an HBCU through a hands-on and mentorship-focused research program. We have utilized the "Scientific Village" model, where students interacted as peers assisting, encouraging, holding each other accountable, and interacted with faculty mentors. Incorporating hands-on research further stimulated and engaged students to enhance interest in STEM curriculum and careers. This was a voluntary, three-year, mixed-method, hands-on research program that tracked a cohort of 60 second-semester STEM students at Benedict College. We conducted a mixed-methods study to examine the impact of a learning community model (the

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Benedict College Scientific Village), fused with critical pedagogy and hands-on laboratory research, on the collegiate success and retention of minority students in the STEM disciplines.

In the next section, we summarized our results. Faculty mentor and student reflections were not included. We compared the participants' performance with control group and participants' placements up on completion of their study.

2.0 Summary of Quantitative Data Analysis on SV Participants' Academic Achievement, Scientific Engagement, and Outcomes

We collected data at all stages of the program including pre and post annual interviews, surveys, graduation, and retention rates on the BC Scientific Village cohort and compared it to a control group of their peers. Specifically from data, we can make the following conclusions.

The GPAs of the Scientific Village (SV) cohort (Group A) were compared with those of their non-SV peers (Group B) to determine the effect of participation in the program. GPA comparisons of participants and corresponding STEM groups at the College are shown in Table 1 for spring 2017 to spring 2019 semesters and graduates. Two sided t-tests after checking equality of variances with F-tests are presented. From the table, it can be seen that all of the p-values of equality of variances tests are greater than 5% significance level. Thus, based on the sample data, we fail to reject the null hypothesis that H_o: $\sigma_A^2 = \sigma_B^2$. Pooled t-tests are then used to test if H_o: $\mu_A = \mu_B$. From right-tailed p-values, we can reject the null hypothesis of equal means for spring 2017, fall 2017, fall 2018, and spring 2018 as one-sided values are half of the values reported in the table. For spring 2017, p-values are both 0.13 where there is some evidence that the mean GPAs of Scientific Village students are higher than the compared STEM groups. Note that SV GPAs are 0.40 and 0.38 higher than the compared group, for spring 2017 and 2019 semesters, respectively. The test result for the graduates fail to reject the null hypothesis with p-value of 0.53 (one sided 0.27 and GPA difference 0.14). Figure 1 shows the positive differences of GPAs for all semesters. SV students showed on average GPA between 16 to 26% improvement over the control group.

Paired-t test results of CURE surveys from SV and all other students are shown in Table 2. From the table, p-values for post graduate plans and post-attitude about science results were fail to reject the null of same mean values. Other test results are all higher than the compared CURE surveys conducted in other programs nationally (Lopatto, 2004, Lopatto, 2010). Overall, our program's survey results are at least met that of mean value of surveys conducted in other programs.

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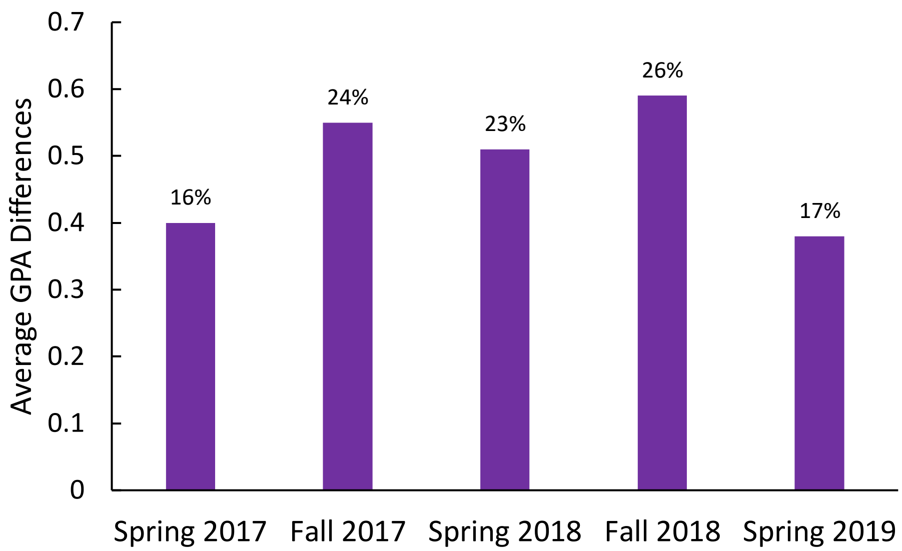

Figure 1. Average GPA differences and percent improvement over control group per semester

Table 1. Comparison of Scientific Village and control group GPAs by semester.

Spring 2017				Fall 2017			
Group	n	$\bar{X}$	S	Group	n	$\bar{X}$	S
A	6	2.90	0.63	A	9	2.84	0.73
B	94	2.50	0.84	B	94	2.29	0.83
$\bar{X}_A - \bar{X}_B$		0.40	0.83	$\bar{X}_A - \bar{X}_B$		0.55	0.83
p-value		0.26	0.53	p-value		0.06	0.74
Spring 2018				**Fall 2018**			
Group	n	$\bar{X}$	S	Group	n	$\bar{X}$	S
A	10	2.76	0.58	A	10	2.85	0.65
B	93	2.25	0.82	B	93	2.26	0.90
$\bar{X}_A - \bar{X}_B$		0.51	0.80	$\bar{X}_A - \bar{X}_B$		0.59	0.88
p-value		0.06	0.25	p-value		0.05	0.30
Spring 2019				**Graduates**			
Group	n	$\bar{X}$	S	Group	n	$\bar{X}$	S
A	10	2.56	1.06	A	13	3.04	0.49
B	93	2.18	0.98	B	43	2.91	0.72
$\bar{X}_A - \bar{X}_B$		0.38	0.99	$\bar{X}_A - \bar{X}_B$		0.14	0.68
p-value		0.25	0.65	p-value		0.53	0.15

Student outcomes were recorded for participants' college experience and post-college experience. College-level outcomes are shown in Table 3a. At the time of this report, 13 out of 25 students (52%) have graduated from Benedict with STEM degrees, none have graduated with a non-STEM degree, 2 (8%) have transferred, 4 (16%) are still pursuing their degrees, and 6 (24%) have dropped out of college (See Table 3).

We made a vigorous attempt to record post-college outcomes for the 21 students who have not yet graduated. To the best of our knowledge, 1 student (5%) is enrolled in graduate school, 1 is applying to nursing school, 2 (10%) are employed in a professional STEM job, 1 is employed in a professional non-STEM job, 2 have joined the military, and 1 is currently seeking professional employment. Outcomes for the remaining 13 students are unknown at this time (See Table 4).

Table 2. Comparison of National CURE survey results with Scientific Village using paired t-tests on specific measures

Pre-Attitude about Science				Post-Attitude about Science			
Group	n	$\bar{X}$	s	Group	n	$\bar{X}$	s
SV	22	3.215	0.731	SV	22	3.255	0.298
All	22	3.037	0.586	All	22	3.147	0.493
Diff		0.178		Diff		0.108	
p-value		0.004		p-value		0.110	
Pre-Skills				**Post-Skills**			
Group	n	$\bar{X}$	s	Group	n	$\bar{X}$	s
SV	25	3.659	0.413	SV	25	3.766	0.025
All	25	3.386	0.287	All	25	3.601	0.016
Diff		0.273		Diff		0.165	
p-value		<0.001		p-value		0.009	
Pre-post College Plans				**Post-post College Plans**			
Group	n	$\bar{X}$	s	Group	n	$\bar{X}$	s
SV	12	0.083	0.010	SV	8	0.125	0.025
All	12	0.083	0.007	All	8	0.125	0.016
Diff		0.000		Diff		0.000	
p-value		0.500		p-value		0.497	

Learning Gains			
Group	n	$\bar{X}$	s
SV	21	4.068	0.016
All	21	3.609	0.037
Diff		0.459	
p-value		<0.001	

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Table 3. College-level outcomes for Scientific Village participants, based on review of their college transcripts and/or personal communications.

College-level outcomes	**Number of Participants**	**Percentage**
Completed SV, graduated Benedict with STEM degree	7	28%
Completed SV, graduated Benedict with non-STEM degree	0	0%
Dropped out of SV, graduated Benedict with STEM degree	6	24%
Dropped out of SV, graduated Benedict with non-STEM degree	0	0%
Transferred to another college, remained in STEM major	2	8%
Transferred to another college, chose a non-STEM major	0	0%
Still pursuing degree	4	16%
Dropped out of college	6	24%
Total	**25**	**100%**

Table 4. Post-college outcomes based on surveys and personal communications.

Post-college outcomes	**Number of Participants**	**Percentage**
Enrolled in graduate/professional school	1	5%
Applying to graduate/professional school	1	5%
Employed in STEM field	2	10%
Employed in non-STEM field	1	0%
Joined military	2	10%
Currently seeking employment	1	5%
Unknown	14	71%
Total	**21**	**100%**

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3.0 Conclusions

This project aimed to study the impact of scientific village or learning community on student retention and success. We aimed to understand when we engage the students in group research if we can keep them more focused to their studies. Although we did not have GPA restriction, none of the students were below 2.75. Results overall showed increase in GPA and retention was about 76%. We did not have any support personnel with the program. However, for better experience for both mentors and students, support personnel to track students and paperwork would be crucial.

As continuation, the team plan to apply similar approach to a larger number of students in the department. In fact, in professional development courses, it is initiated to all faculty to mentor all students in this mandatory class to expose them to continuous experiential learning during their study.

4.0 References

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