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# *Pilot Study to Develop an Augmented Student Support Needs Scale to Address the Needs of HBCU Students*

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*The authors completed a pilot study to examine the original Student Support Needs Scale (SSNS) and alternative forms. They assessed how the items were related to each other, how SSNS versions correlated with each other, and the SSNS versions associations with measures of student attitudes and performance. Eighty students from a historically Black college and university participated. SSNS 10-item- and 5-item-per-scale forms were created. They were compared with the original, to each other, and to other measures. The coefficients related to how items related to each other indicated that the alternative forms had similar to better correspondence between related items than the original scales. The 5-item-per-scale version was used as the augmented SSNS (SSNS-A). SSNS-A correlations with measures of student attitudes and performance were generally in the expected direction. Implications are discussed in regard to reliability and validity of the SSNS-A.*

***Keywords***: *STEM education, historically Black college and university (HBCU), student support, assessment of student support*

Science, technology, engineering, and mathematics (STEM) education trends in the United States indicate that African American students are underrepresented in STEM baccalaureate degrees (National Science Foundation, National Center for Science and Engineering Statistics, 2017). Compared to White, Hispanic, and Asian STEM students African American students had greater attrition rates for men and women (Ma & Liu, 2017). However, their probability of degree completion increased by three to five times when mathematics preparation and socioeconomic factors are equated to Asian students (Ma & Liu, 2017). African American students might not have, or might lose, opportunities to improve graduation rates from STEM fields. African American students have few retention support systems that are based on validated comprehensive theoretical models. Therefore, assessing support areas that may theoretically contribute to African American student retention in STEM fields are needed.

## Student Retention

Pre-college skills and school success are related to commitment to college completion (Palmer, Davis, & Thompson, 2010). However, integration into the academic and social context of pre-college skills and school success is viewed as the primary component of student persistence (Alkhasawneh & Hobson Hargraves, 2014). Integration includes access to campus resources to develop relationships with faculty and peers as an essential element (Palmer, Davis, & Thompson, 2010). Faculty and peer interactions should occur regularly inside and outside of classes (Tinto, 2010).

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Faculty-related integration practices that lead to retention include clear expectations, support, and feedback in courses and the program of study. The assessments used by instructors should indicate who has mastered course materials or who needs additional support (Tinto, 2010). This allows students to gain an understanding of the explicit and implicit expectations of instructors (Tinto, 2010). Peer-related integration activities involve students participating in structured academic-focused social programs (e.g., study groups). These social programs introduce students to their institutions and keep them engaged in the culture of the college campus (Tinto, 2010). Students also need financial support to attend college, which could include money dedicated to school costs (Tinto, 2010).

STEM program developers have used student support systems to retain underrepresented minorities. STEM student support programs require student participation in research and leadership roles, prioritization of academic and extracurricular activities, learning time management skills, socialization with peers and faculty, and incentivized retention through scholarships (Payton, Suarez-Brown, & Smith Lamar, 2012). Other STEM programs have adopted models for student research apprenticeships and research team participation. This includes mentoring to balance academic, family, and extracurricular responsibilities (Leggett-Robinson, Reid Mooring, & Villa, 2015). Comparable models have included peer-led team learning, where peers lead modules of faculty-developed materials (Gasman et al., 2017). Generally, these elements are combined based on conceptual models for promoting retention of underrepresented minority groups, but not necessarily well-identified theoretical models. However, the constructs adopted by STEM programs have yet to be consistently assessed with African American students.

## Performance Pyramid Model

The performance pyramid is a theoretical model proposed to improve STEM student retention (Watkins & Wedman, 2003) and it has been adapted to relate to the needs of African American STEM students (e.g., Mwaikinda, & Aruguete, 2016). The purpose of the performance pyramid model is to comprehensively identify and assess student needs (Watkins, West Meiers, & Visser, 2012). It has six interrelated elements: (a) Expectations and Feedback; (b) Tools, Environment, and Processes; (c) Rewards, Recognition, and Incentives; (d) Motivation and Self-Concept; (e) Performance Capacity, and (f) Knowledge and Skills (Wedman, 2010; Wedman & Diggs, 2001).

The Expectations and Feedback area is related to explicit information regarding courses or degree requirements and how to complete them. Tools, Environment, and Processes refers to access to physical resources, opportunities to engage in degree-related tasks, and organizational support (Park & Ertmer, 2008; Watkins, West Meiers, & Visser, 2012; Wedman & Diggs, 2001). Rewards, Recognition, and Incentives is related to receiving acknowledgements and incentives for academic performance (Park & Ertmer, 2008; Schaffer & Richardson, 2004; Watkins, West Meiers, & Visser, 2012; Wedman & Diggs, 2001). Motivation and Self-Concept is the extent to which individuals perform because they see benefits related to the academic task and desire to continue with related tasks in their careers (Park & Ertmer, 2008; Watkins, West Meiers, & Visser, 2012). Performance Capacity refers to environmental, interpersonal, and intrapersonal resources for work completion (Park & Ertmer, 2008; Schaffer & Richardson, 2004; Wedman, 2010). Knowledge and Skills refers to adequate academic preparation for courses and degree programs (Park & Ertmer, 2008; Watkins, West Meiers, & Visser, 2012). Nonetheless, no performance pyramid assessment that is endorsed by the theory developers, but they have repeatedly identified that empirical examinations the performance pyramid elements and assessment tools are needed (Watkins & Wedman, 2003; Watkins, West Meiers, & Visser, 2012).

## Student Support Needs Scale

The Student Support Needs Scale (SSNS) was designed by Hardy & Aruguete (2014) to represent the performance pyramid theoretical framework and measure the support needs of African

American STEM and non-STEM students. It was piloted within a historically Black college and university (HBCU) using a sample ($N$ = 300) of 48% White and 44% African American, as well as 45% STEM major and 48% non-STEM major students. Since the SSNS was initially appraised with all the data aggregated across student racial categories and majors, it might need to be reappraised with a sample consisting of larger proportions of African American and STEM groups to represent better them.

During the initial development, 48 items were created, where there were eight items for each of the six areas of the performance pyramid. A principal component analysis (PCA) identified six factors across 36 items (for full analysis description see Hardy & Aruguete, 2014): Knowledge (Cronbach's alpha ($\alpha$) = .73), Performance (.76), Motivation (.79), Tools/Environment (.80), Feedback (.87), and Self-Efficacy (.62; Hardy & Aruguete, 2014). An overall SSNS score (Cronbach's $\alpha$ = .90) was calculated and correlated positively with grade point average (GPA; $r$ = .17), major GPA ($r$ = .30), office hours visited ($r$ = .18) and was negatively associated classes missed ($r$ = -.21; Hardy & Aruguete, 2014). Still, scale intercorrelations, and correlations between individual scales and outcomes were not computed.

The SSNS might aid performance pyramid evaluation, but the PCA-derived Feedback factor included items intended for the separate constructs of Expectations and Feedback and the Rewards, Recognition, and Incentives items. Moreover, the Self-efficacy factor was not predicted by the model and the items potentially cannot be interpretable directly as self-efficacy (Hardy & Aruguete, 2014), but self-efficacy is related to support elements (e.g., Yusoff, 2012). The initial SSNS items might have missed distinguishing related concepts by not including items to differentiate Expectations and Feedback and the Rewards, Recognition, and Incentives, or added concepts that were not explicitly stated in the performance pyramid, such as self-efficacy. Given these issues, creating additional SSNS items consistent with the performance pyramid could be useful, but item reduction might be needed to preserve the practicality of the SSNS. Also, comparing the SSNS with prior knowledge, attitudes, motivation, and dispositions could help connect the SSNS to other retention related factors.

## Current Study

The purpose of the current research was to complete a pilot study on an augmented form of the SSNS. The authors sought to answer of the following questions related to the SSNS and its augmented form:

- Can an internally consistent, augmented SSNS be developed?
- What are correspondences between the SSNS and augmented SSNS subscales?
- How do the augmented SSNS subscales correspond to independent measures of student attitudes, motivation, dispositions, and prior knowledge?

It was hypothesized that we could generate an internally consistent augmented version of the SSNS with strong correlations ($r \geq .70$) between the SSNS and augmented SSNS subscales. The relations between the augmented SSNS scales and measures of student attitudes, motivation, dispositions, and prior knowledge were expected to be positive; however, the exact magnitudes were considered exploratory due to the initial development of the scales.

## Method

### *Setting and Participants*

This study took place at an urban HBCU in the southern United States. The enrollment was approximately 750 students with a six-year graduation rate of 52%. This pilot study was part of a program to increase biology student retention through social and academic support. Participants

included 80 undergraduate students ($M_{age}$ = 18.54, $SD$ = 1.09), which is adequate for piloting an instrument (i.e., $N \geq 30$; Johanson & Brooks, 2010). Seventy-eight of the participants identified as African American or of African descent and 54 of the participants were women. The majority of students ($n$ = 62) were first-year college students. Sixty-four students identified as STEM majors, 12 students undeclared or undisclosed majors, and four were non-STEM.

### *Measures*

**Student Support Needs Scale (SSNS).** The SSNS (Hardy & Aruguete, 2014) contains 36 items that are rated on a six-point scale (1 = *Strongly disagree* to 6 = *Strongly agree*). Higher item mean scores indicate greater presence of each element.

**SSNS-Augmented (SSNS-A).** The authors adapted the SSNS-A from the SSNS. The items from the 36 item SSNS were used and new items were added to create a measure with 10-item subscales across performance pyramid areas for a total of 70 items. We generated items based on the areas of the performance pyramid (see Watkins, West Meiers, & Visser, 2012). We created additional items for SSNS scales, and the Feedback scale was restructured into two scales. The additional items and scales were intended to reflect the performance pyramid model better. The SSNS-A has seven subscales: (a) Knowledge, (b) Performance, (c) Motivation, (d) Tools/Environment, (e) Feedback-Procedural Expectations (Feedback-PE), (f) Feedback-Rewards, Recognition, and Incentives (Feedback-RRI), and (g) Self-efficacy. Higher item mean scores indicate greater presence of each element. The 10-item per scale full form was reduced to a 5-item per scale, 35-item form. Items were removed to increase SSNS efficiency.

For the SSNS-A, the Knowledge subscale contains items related to academic preparation regarding prerequisite knowledge needed to succeed in major courses. The Performance subscale items relate to completing individual and group assignments, and passing examinations. The Motivation subscale relates to interest and positive outlook related to one's major. The Tool/Environment subscale represents institutional resources dedicated to academic work completion. The Feedback-PE subscale represents instructor feedback to students regarding expectations of students and student performance. The Feedback-RRI subscale items involve the identifying that instructors provide recognition, rewards, and incentives for performance. The Self-efficacy subscale measures perceived competency at course related tasks.

**Subjective Science Attitude Change Measures (SSACM).** The SSACM assesses students' perceptions of an educational program providing positive changes or instructional impact in science motivation, confidence, knowledge, and student relationships (Deemer et al., 2014; Stakes & Mares, 2001). The 23-items use a seven-point rating system with three anchors (1 = *Not at all*, 4 = *Somewhat*, and 7 = *A great deal*). There are four scales: (a) Increased science motivation, (b) Increased science confidence, (c) Increased science knowledge, and (d) New social niche. Higher mean-item scores on the scales of the SSACM indicate increased motivation, confidence, knowledge, and social networks, respective to the scales.

Increased science motivation measures the instructional impact on students' perceived enthusiasm and interest for science. Increased science confidence indicates instructional impact on students' perceived self-assurance in science learning and career prospects. Increased science knowledge measures instructional impact on students' perceived understanding of science. New social niche measures instructional impact on students' perceived development of a social network related to science. Increased science motivation, Increased science confidence, and Increased science knowledge have six items. New social niche has five items.

**Math Barriers Scale–Math Anxiety (MBS).** The MBS measures anxiety related to completing math course work (Hendy et al., 2014). The eight MBS items are rated on a five point rating scale (1 = *almost never* to 5= *almost always*). Higher mean-item scores indicate a greater presence of math anxiety (Hendy et al., 2014).

**Marlowe-Crowne Social Desirability Scale-Short Form (MC).** The MC is a 13-item short form of the Marlowe-Crowne Social Desirability Scale (Reynolds, 1982). The MC assesses the desire to conform to low frequency, yet highly desirable social behaviors. Raters indicate either true or false to each item, which are scored as 0 or 1. Higher item summed scores indicate more willingness to conform to social rules and conventions, whereas lower scores indicate a greater willingness to answer truthfully regardless of social approval (Reynolds, 1982).

**Student Survey.** A student demographic and background survey was created. High school GPA and American College Test (ACT) composite score were selected as indicators of previous academic performance. Reported SAT Total scores were converted to an ACT composite score through the official concordance tables (The College Board, ACT, 2018). Gender and declared STEM major were assessed as covariates. Gender differences have been demonstrated for ratings and predictions of STEM student perceived supports and values (Else-Quest, Mineo, & Higgins, 2013; Simon et al., 2015). Gender was coded 0 = *female* and 1 = *male*. Differences in ratings of goals and attitudes between non-STEM and STEM majors has support (Diekman et al., 2011). Participants were coded 0 = *Non-STEM* and 1 = *STEM*.

### *Data Collection Procedures*

Course instructors of College Algebra, Calculus I, and General Biology gave permission to conduct the survey during their classes. Research team members shared information regarding the study, and then students who consented to participate were given a paper-and-pencil format survey packet to complete. Research team members collected the packets immediately after completion. All procedures were approved by the institutional review boards at the HBCU and partnering university.

### *SSNS-A Development Procedures*

A series of procedures were used to determine if an augmented version of the SSNS could yield viable subscales by assessing if they were similar or more internally consistent than the original SSNS and subscales. Cronbach's α and intercorrelations were compared across the 10-items and 5-item per scale versions of the SSNS-A.

The decision to remove items for the 35-item version was based on a multistep process, where (1) the change in α was examined; (2) the inclusion of both original and new items were considered; and (3) assuring a breadth of construct coverage was emphasized. Items were considered for deletion when their inclusion would result in $\alpha < .70$ or $\alpha > .95$ (excessive redundancy; Bland & Altman, 1997; Tavakol & Dennick, 2011). The inclusion of original items and new items used the rule that at least two original items should be selected because they reflected theoretically relevant and previously tested relations, if the original items did not result in $\alpha < .70$. For assuring breadth of factor coverage, items that equally contributed to respective subscales were read for redundant wording. If there was similar wording, one of the items was removed.

Within the 10- and 5-item per subscale versions of the SSNS-A, the mean intercorrelations were taken to examine the overall inter-scale correlations. To do this, a Fischer's *z*-transformation of the Pearson's *r* correlations was completed. The scores were then averaged and then converted back to a Pearson's *r*. To compare the respective 10- and 5-item subscales, McDonald's omega (ω) with Bootstrap corrected 95% confidence intervals [BC 95% C.I.] were calculated in Mplus 8.0 (Muthén & Muthén, 2017) and the confidence intervals were examined for overlap. McDonald's ω allows for comparisons of the general item consistency between different versions of the same subscale (Dunn, Baguley, & Brunsden, 2013).

### *Primary Analyses*

The following analyses were completed in SPSS v.24 (IBM Corp., 2016) using list-wise deletion to handle missing data due to the small sample size and limited missing data. Means, standard deviations, and Cronbach's α were calculated for the original SSNS, SSNS-A, SSACM, SIMS, MBS, and MC. Descriptive statistics were also calculated for the participants' overall high school GPA and ACT composite score. Due to the significant relation between gender and the SSNS subscales, Pearson's *r* partial correlations that controlled for gender were computed for the analyses of association. The authors calculated partial correlations for the SSNS and SSNS-A with the rating scales, as well as overall high school GPA and ACT composite score.

## RESULTS

### *SSNS-A Item Reduction*

In general, the authors retained the same subscale names and at least two of each scales' items from the SSNS for the SSNS-A, but there were exceptions. The SSNS Feedback subscale was split into two subscales because some items related to instructional feedback (Feedback-PE), whereas other items related to rewards given for performance (Feedback-RRI). While elements of these subscales might often coincide, they could also be conceptualized as separate elements of the instructional process. Additionally, the SSNS-A Self-efficacy 5-item subscale did not include any of the original items because they seemed conceptually less consistent with each other, and had the least association with the other items generated from the performance pyramid. See Table 1 for items retained for the short SSNS-A (request to the first author for all items). All SSNS-A subscales were highly intercorrelated within the long and short versions. It was found that the long ($r_{long}$ = .65) and short ($r_{short}$ = .66) forms had a high average intercorrelation between all respective subscales. In general, both forms have similar subscale relatedness (Table 2).

Comparisons across the SSNS, and SSNS-A 10-item and 5-item subscales using omega coefficients (ω [BC 95% C.I.]) generally demonstrated consistency across forms (Figure 1). The SSNS Knowledge, Tools/Environment (ω = .93 [.89, .96]), Feedback (ω = .91 [.85, .94]), and Self-efficacy (ω = .81 [.72, .86]) subscales had adequate internal consistency. However, the coefficients for the Performance (ω = .62 [.45, .73]) and Motivation (ω = .41 [.18, .94]) subscales were lower. The SSNS-A 10-item and 5-item subscales generally had significant, positive, and large correlations between corresponding subscales. The SSNS-A Knowledge subscale 10-item version (ω = .93 [.89, .96]) correlated with the 5-item version (ω = .88 [.81, .93]). The 10-item Performance subscale (ω = .67 [.43, .78]) correlated with the 5-item form (ω = .67 [.50, .75]). The Motivation 10-item subscale (ω = .65 [.37, .94]) had the lowest relation with the respective shorter version; however, the 5-item version (ω = .94 [.89, .96]) had greater homogeneity between items. As for the Tools/Environment subscale, the long (ω = .94 [.90, .96]) and short (ω = .90 [.84, .94]) version had a strong correspondence. The 10-item Feedback-Procedural subscale (ω = .92 [.88, .95]) had a large association with the 5-item format (ω = .87 [.79, .92]). Similarly, the Feedback-RRI long (ω = .93 [.89, .96]) and short (ω = .89 [.82, .94]) form had strong correspondence. The Self-efficacy subscale 10-item (ω = .87 [.82, .91]) and 5-item (ω = .92 [.87, .96]) formats were highly correlated. Overall, the comparisons between SSNS-A long and short forms indicated that they were similar, with the exception of the Motivation scale, which had an improved ω in the 5-item version. Therefore, the short-form may provide the most efficient format of the SSNS-A and it was selected as the representative SSNS-A form for the remaining comparisons.

**Table 1**

*Student Support Needs Scale Augmented (SSNS-A) Items by Scale with Original and New Indicated*

| Scale | Items | Original /New |
|---|---|---|
| *Knowledge* | I have a strong enough math background to do well in my major | Original |
| | I have a strong enough science background to do well in my major | Original |
| | I have good academic preparation for my major. | Original |
| | I continue to develop knowledge to perform well in my major. | New |
| | I continue to develop knowledge from other courses that help me to do well in my major. | New |
| *Performance* | Conflicting responsibilities sometimes make me miss classes. (reverse scored) | Original |
| | I have enough time to devote to my studies. | Original |
| | I receive passing grades from instructors on exams in my major. | New |
| | I typically cooperate with peers to do well on group assignments in my major. | New |
| | I complete assignments on or before their due date. | New |
| *Motivation* | I have clear career goals related to my major. | Original |
| | I am proud to tell people about my major. | Original |
| | I am fascinated by the material in my major. | Original |
| | I see that doing well in my major courses will help me in my career. | New |
| | I see the benefit of doing well in courses that are related to my major. | New |
| *Tools/ Environment* | If I have a question about my major, the university provides the resources to get the answer quickly. | Original |
| | The university has many institutional processes that promote success in my major. | Original |
| | Academic tutoring is available to me in my major. | Original |
| | I have a place to where I can study on campus on my own if I need to. | New |
| | My university provides me with a space to work with peers on assignments related to my major. | New |
| *Feedback-Procedural* | I get enough feedback about my performance in my major. | Original |
| | My major instructors give me the feedback I need to correct my performance problems when they occur. | Original |
| | I have a lot of contact with faculty members in my major. | Original |
| | My major instructors clearly identify what is expected on assignments. | New |
| | My major instructors let the class know how they did as a group. | New |
| *Feedback-RRI* | In my major, instructors reward good performance. | Original |
| | My instructors recognize my accomplishments. | Original |
| | I understand how come other students earn awards for their performance. | New |
| | I am recognized by my major instructors when I do well in class. | New |
| | Grades in my major courses are given based on level of performance. | New |
| *Self-Efficacy* | I am capable of completing tasks related to my major. | New |
| | I am confident that I will pass all tests in my major courses. | New |
| | I am likely to do well on majors courses' assignments. | New |
| | As major courses become more difficult, I believe I will do well. | New |
| | I can figure out how to correct assignments in my major courses | New |

**Table 2**

*Correlations for the Student Support Needs Scale Augmented (SSNS-A) Versions with Scales Means (M), Standard Deviations (SD), and Cronbach's alpha (α)*

| | | 10-Item per Scale | | | | | | | 5-Item per Scale | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| *10-Item* | | | | | | | | | | | | | | | |
| | 1 | - | .60 | .64 | .75 | .72 | .65 | .77 | **.98** | .70 | .71 | .75 | .67 | .65 | .81 |
| | 2 | | - | .46 | .59 | .55 | .46 | .73 | .59 | **.86** | .55 | .62 | .48 | .47 | .64 |
| | 3 | | | - | .61 | .49 | .39 | .51 | .60 | .58 | **.81** | .61 | .42 | .36 | .54 |
| | 4 | | | | - | .83 | .71 | .72 | .72 | .63 | .73 | **.98** | .80 | .70 | .74 |
| | 5 | | | | | - | .77 | .70 | .69 | .56 | .60 | .80 | **.97** | .78 | .68 |
| | 6 | | | | | | - | .62 | .62 | .43 | .45 | .65 | .75 | **.96** | .67 |
| | 7 | | | | | | | - | .77 | .69 | .66 | .72 | .64 | .62 | **.90** |
| *5-Item* | | | | | | | | | | | | | | | |
| | 1 | | | | | | | | - | .69 | .69 | .71 | .64 | .63 | .80 |
| | 2 | | | | | | | | | - | .67 | .64 | .46 | .45 | .68 |
| | 3 | | | | | | | | | | - | .74 | .54 | .46 | .66 |
| | 4 | | | | | | | | | | | - | .76 | .64 | .72 |
| | 5 | | | | | | | | | | | | - | .76 | .61 |
| | 6 | | | | | | | | | | | | | - | .67 |
| | 7 | | | | | | | | | | | | | | - |
| | *N* | 79 | 79 | 78 | 79 | 79 | 79 | 79 | 79 | 79 | 78 | 79 | 79 | 79 | 79 |
| | *M* | 4.51 | 4.14 | 4.76 | 4.59 | 4.32 | 4.14 | 4.56 | 4.46 | 4.44 | 5.06 | 4.64 | 4.29 | 4.23 | 4.65 |
| | *SD* | 0.92 | 0.74 | 1.09 | 0.98 | 0.93 | 0.98 | 0.83 | 0.99 | 0.86 | 1.03 | 1.04 | 1.01 | 1.00 | 1.01 |
| | α | 0.93 | 0.71 | 0.64 | 0.93 | 0.93 | 0.93 | 0.87 | 0.89 | 0.71 | 0.93 | 0.90 | 0.87 | 0.89 | 0.92 |
| | $M_{intercorrelation}$ | .69 | .57 | .52 | .68 | .69 | .61 | .68 | .70 | .61 | .64 | .71 | .64 | .62 | .70 |

*Note.*

$M_{intercorrelation}$ = mean *z*-score transformed intercorrelations between SSNS and SSNS-A subscales, within each respective scale. 1 = Knowledge; 2 = Performance; 3 = Motivation; 4 = Tools/Environment; 5 = Feedback–Procedural; 6 = Feedback–Rewards, Recognition, and Incentives; 7 = Self-Efficacy. Intercorrelations between versions of the same scales are **bold**. All Pearson's correlations $p \leq .001$.

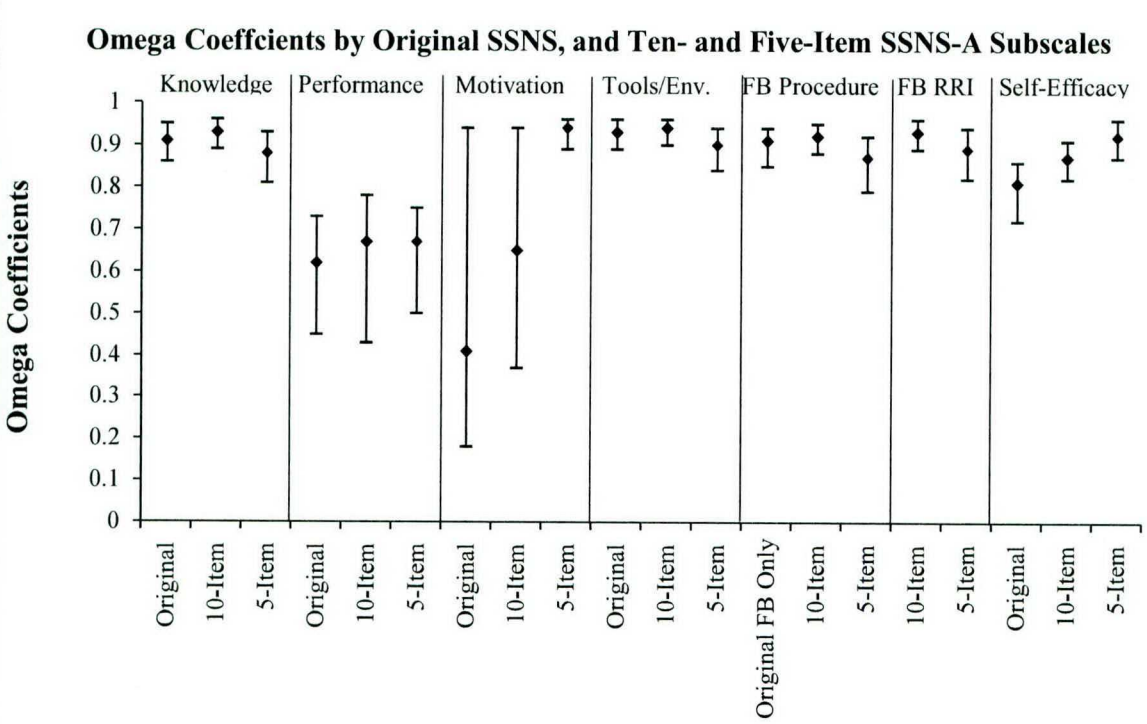


*Figure 1.* McDonald's omega coefficients with 95% confidence intervals by original Student Support Needs Scale (SSNS), and 10-item and 5-item subscales on the SSNS-Augmented (SSNS-A), respectively. *Notes.* Tools/Env. = Tools/Environment scale. FB Procedure = Feedback – Procedural scale. FB RRI = Feedback – Rewards, Recognition, and Incentives scale. Original = respective SSNS scale. 10-Item = respective ten-item SSNS-A scale. 5-Item = respective five-item SSNS-A scale. Original FB Only = Original SSNS Feedback scale.

### *SSNS-A and SSNS Associations*

Regarding covariates, a multivariate analysis of variance (MANOVA) indicated that there was a significant difference between men and women on the SSNS subscales, $F(6, 68) = 2.72$, $p = .020$, Wilk's $\Lambda = .81$. The univariate analysis indicated differences between women had higher ratings than men for the Tools/Environment subscale, $F(1, 73) = 11.98$, $p = .001$, Cohen's $d = 0.89$, and Feedback subscale, $F(1, 73) = 6.25$, $p = .015$, Cohen's $d = 0.64$. A MANOVA indicated non-significant differences between men and women on the SSNS-A subscales, as well as non-significant differences between non-STEM and STEM students on the SSNS and SSNA-A subscales (full results available upon request to the first author).

The reliability of most SSNS subscales were acceptable, but the Performance and Motivation scales had low reliability coefficients. The SSNS Self-efficacy scale only significantly correlated with the Performance subscale. The significant correlations between all other subscales were positive and ranged from weak to strong. The correspondence between the respective SSNS and SSNS-A subscales were positive and ranged from negligible to strong. The Self-efficacy subscales were unrelated, and the Performance and Motivation subscales were moderately related. The Knowledge and Tools/Environment subscales were strongly correlated across the SSNS and SSNS-A. Furthermore, the SSNS Feedback subscale strongly associated with SSNS-A Feedback-PE and Feedback-RRI. Altogether, the SSNS and SSNS-A likely have overlapping factors across the same or similar subscales, with the exception of Self-efficacy. Table 3 has descriptive statistics and intercorrelations between the SSNS and SSNS-A subscales.

**Table 3**

*Descriptive Statistics and Correlations between Scales on the Student Support Needs Scale (SSNS) and SSNS-Augmented Short Form (SSNS-A)*

| | SSNS | | | | | | SSNS-A | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Scale** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | ***N*** | ***M*** | ***SD*** | **α** | $M_{intercorrelation}$ |
| 1 | -- | .32 ** | .46 *** | .68 *** | .68 *** | .16 | **.96** *** | .63 *** | .60 *** | .67 *** | .60 *** | .61 *** | .79 *** | 79 | 4.38 | 1.01 | .90 | .59 |
| 2 | | -- | .24 * | .41 *** | .36 ** | .45 *** | .36 *** | **.63** *** | .24 * | .42 *** | .34 ** | .26 * | .41 *** | 79 | 3.95 | 0.89 | .60 | .39 |
| 3 | | | -- | .47 *** | .38 *** | .07 | .51 *** | .53 *** | **.67** *** | .50 *** | .31 ** | .27 * | .49 *** | 78 | 4.98 | 1.54 | .38 | .36 |
| 4 | | | | -- | .79 *** | .14 | .71 *** | .60 *** | .65 *** | **.94** *** | .77 *** | .64 *** | .70 *** | 79 | 4.55 | 1.10 | .93 | .69 |
| 5 | | | | | -- | .20 | .72 *** | .55 *** | .56 *** | .77 *** | **.91** *** | **.88** *** | .71 *** | 79 | 4.24 | 0.89 | .91 | .65 |
| 6 | | | | | | -- | .19 | .27 * | .17 | .17 | .22 | .13 | **.16** | 79 | 4.23 | 1.13 | .78 | .21 |

*Notes.* * $p \leq .05$; ** $p \leq .01$; *** $p \leq .001$. $M_{intercorrelation}$ = mean z-score transformed intercorrelations between SSNS and SSNS-A subscales, excluding the corresponding scale. SSNS original subscales: 1 = Knowledge; 2 = Performance; 3 = Motivation; 4 = Tools/Environment; 5 = Feedback; 6 = Self-Efficacy. SSNS-A subscales: 7 = Knowledge; 8 = Performance; 9 = Motivation; 10 = Tools/Environment; 11 = Feedback–Procedural. 12 = Feedback–Rewards, Recognition, and Incentives; 13 = Self-Efficacy. Intercorrelations between same or similar versions of the SSNS and SSNS-A scales are **bold**.

**Table 4**

*Partial Correlations[a] between the Student Support Needs Scale-Augmented (SSNS-A), and the Subjective Science Attitude Change Measures (SSACM), Math Barriers Scale–Math Anxiety (MBS), Marlowe-Crowne Social Desirability Scale-Short Form (MC), High School Grade Point Average (GPA), and ACT Score*

| | SSACM | | | | MBS | MC | GPA | ACT |
|---|---|---|---|---|---|---|---|---|
| | MOT | CONF | SCI | NICHE | | | | |
| SSNS-A | | | | | | | | |
| 1 | .35** | .41*** | .44*** | .30** | -.27* | .30** | .27* | .21 |
| 2 | .26* | .28* | .27* | .10 | -.23 | .28* | .22 | .09 |
| 3 | .33** | .36** | .41*** | .26* | -.07 | .29* | .15 | .15 |
| 4 | .45*** | .48*** | .56*** | .47*** | -.03 | .17 | .23 | .08 |
| 5 | .49*** | .45*** | .51*** | .49*** | .02 | .06 | .08 | .20 |
| 6 | .35** | .33** | .38*** | .38*** | .03 | .13 | .06 | .22 |
| 7 | .29* | .35** | .37*** | .29* | -.26* | .16 | .24* | .19 |
| *M* | 4.68 | 4.79 | 4.94 | 4.79 | 2.74 | 8.42 | 3.38 | 21.24 |
| *SD* | 1.57 | 1.67 | 1.44 | 1.50 | 1.04 | 2.45 | 0.46 | 4.44 |
| *N* | 79 | 79 | 79 | 79 | 72 | 77 | 75 | 62 |
| α | .96 | .98 | .91 | .92 | .94 | .61 | | |

*Note.* * $p \leq .05$; ** $p \leq .01$; *** $p \leq .001$. [a] Controlling for gender; SSNS-A subscales: 1 = Knowledge; 2 = Performance; 3 = Motivation; 4 = Tools/Environment; 5 = Feedback–Procedural Expectations. 6 = Feedback – Rewards, Recognition, and Incentives; 7 = Self-Efficacy. SSACM scales: MOT = science motivation; CONF = science confidence; SCI = science knowledge; and NICHE = new social niche.

### *SSNS-A Associations with Student Characteristics*

Table 4 has the correlations between the SSNS-A short form and SSACM scales, and student dispositions and prior knowledge. Across all of the SSACM scales, the SSNS-A Tools/Environment and Feedback-PE subscales consistently had the largest positive correlations. That is, having tools to access resources and receiving feedback were strongly associated with increased motivation for science, confidence to do well in science, perceived understand of course work, and perceived social support. The SSNS-A Knowledge subscale had similar positive associations with science knowledge and science confidence. However, Knowledge, Feedback-RRI, and Self-efficacy had similar positive associations with understanding science course work. Feedback-RRI had a positive correspondence with social support in science.

Overall, math anxiety had similar negative correlations with SSNS-A Knowledge and Self-efficacy. Comparable positive correlations were observed between high school GPA and the Knowledge and Self-efficacy subscales. Social desirability was correlated positively with the SSNS-A Knowledge, Performance, and Motivation subscales. That is, students who reported better academic preparation, assignment completion, and interest in their major were more likely to identify as conforming to social conventions.

## Discussion

The purpose of this study was to pilot an augmented form of the SSNS to answer questions related to internal consistency, determine correspondences between the original SSNS and the SSNS-A, and examine relationships between the SSNS-A and measures of student motivation, attitudes, and prior knowledge. The data indicated that the SSNS-A long and short form subscales had sufficiently related items, with the exception of Self-efficacy. The short and long form subscales had similar Cronbach's $\alpha$ and McDonald's $\omega$ coefficients. The exception was the shorter form of the Motivation subscale, which had more desirable reliability coefficients, and much closer confidence intervals around the $\omega$ coefficient. These results indicate adequate internal consistency reliability for both the SSNS-A long and short form.

The corresponding subscales on the SSNS and SSNS-A short form tended to correlate strongly with each other, apart from the Self-efficacy subscales. This is not surprising as other Knowledge, Performance, Motivation, Tools/Environments, and Feedback subscales contain overlapping items, whereas the SSNS and SSNS-A Self-efficacy subscales share no items in common. These strong correlations, with the exception of Self-efficacy, provide concurrent validity evidence indicating that the corresponding scales on the SSNS-A forms measure similar constructs as the original SSNS (Godwin et al., 2013). Additionally, it is of note that internal consistencies for both the 10 and 5-item SSNS Self-efficacy were considerably higher than those obtain by Hardy & Aruguete (2014) who obtained an alpha of .62. However, without a third validated self-efficacy measure, it is uncertain which scale best represents self-efficacy.

The SSNS-A short form subscales tended to correlate with measures of attitudes and motivation, but to different degrees. The Knowledge and Self-efficacy subscales were negatively correlated with math anxiety and positively correlated with high school GPA. However, these correlations were weak, indicating that neither of these variables are strongly associated with GPA or math anxiety. Knowledge, Performance, and Motivation were significantly correlated with social desirability though these correlations were weak as well. Additionally, ACT composite scores were not significantly associated with the SSNS-A subscales.

There are several factors that are theorized to predict retention and success of students in STEM disciplines. Based on progressing theories, STEM students need support across multiple areas to remain in, and complete, their degree programs (Alkhasawneh & Hargraves, 2014; Astin, 1984; Heiberger & Harper, 2008; Tinto, 2010). The performance pyramid model includes many of these elements (Park & Ertmer, 2008; Watkins, West Meiers, & Visser, 2012; Wedman & Diggs, 2001) and the SSNS was developed to assess the key elements of this support model (Hardy & Aruguete, 2014). However, it appears from our pilot study that the SSNS-A may possess limited concurrent validity evidence, in the areas of math anxiety, GPA, and ACT scores, all of which are

highly correlated with success in higher education, especially during a student's first year (Westrick et al., 2015). Nonetheless, the negative correlations between SSNS-A Knowledge and Self-Efficacy subscales with math anxiety, and their positive correlations with high school GPA are promising.

## Limitations

This study was designed to develop an augmented SSNS and was above the recommended sample size for piloting an instrument (Johanson & Brooks, 2010); however, it has multiple limitations. Specifically, a sample size of 80 participants can assist in measurement development to find general issues related to basic psychometrics. Nonetheless, more rigorous tests of factor structures rely on larger sample sizes that allow for more advanced analyses, such as factor analysis techniques. Relatedly, the internal consistency and correlation coefficients could apply to the HBCU's student body as approximately 11% were sampled. However, individuals should proceed cautiously in attempts to generalize the results to other HBCUs, colleges, or across majors. The heterogeneity of the sample should not lead to broad generalizations, rather should be viewed as understanding how the SNSS and SSNS-A items related to each other within the study's university. Broader psychometric assessments across HBCUs and other universities would allow for generalizing the measures' properties to different student populations.

In order to better understand the SSNS-A and how it can be broadly used to assess African American STEM student needs, a few areas would need to be further developed. For instance, purposeful sampling across students from different STEM disciplines is needed to examine if needs are correspondingly related to the SSNS-A across disciplines. Similarly, it could be reasonable to expect that actual and perceived support needs could change as students matriculate through a STEM program. Therefore, sampling across academic classes along with more advanced analytic techniques, such as multi-group or longitudinal invariance testing, could provide valuable information about construct consistency across academic classes. Another consideration is whether HBCUs provide more supports for students as a function of their approach to education compared to their predominantly White institution (PWI) counter parts (Arroyo & Gasman, 2014). That is, differences in support needs for African American STEM students across types of institutions likely needs consideration. Furthermore, the SSNS and related forms could be distributed and analyzed widely, but this relies on self-report. Correspondingly, this study relied on self-report, therefore future endeavors should incorporate either independent ratings (e.g., faculty or advisors) or direct data, such as observations or confirmed assessment outcomes related to major content.

## Conclusion

There are multiple theorized frameworks of student supports for improving STEM performance of HBCU students. However, examinations of the factors related to the supports have received limited attention prior to design and implementation of interventions based on them. The current study attempted to develop an assessment grounded in the performance pyramid framework to evaluate student supports at an HBCU. It was found that an augmented form of the SSNS, the SSNS-A, with five items on each the seven scales had internally consistent scales. However, there were high intercorrelations between scales and inconsistent correlations to other measures. In summation, the SSNS-A scales have adequate internal consistency, but broader reliability and validity questions require more investigation.

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