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STRENGTH IN NUMBERS: PSYCHOMETRICS OF THE STEM-US QUANTITATIVE ASSESSMENT

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MOREHOUSE | SPELMAN | VIRGINIA STATE



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INTRODUCTION

This is the second in a series of papers intended to update the HBCU STEM-US Community on research findings associated with the Analytic Hub. You have heard of White Papers, which are defined as a brief publication that succinctly explains or describes a narrow topic. We have coined the term “Black Papers” to describe something else...a source document that covers many topics and provides the broader context from which multiple related White Papers will come. Although this writing will document scientific findings, it is not meant to be a manuscript. The writing tense is not in the passive third person but is in a plural active voice. This better reflects the intentions of people who are actively contributing to a body of work meant to better understand other human beings. Additionally, since text has been gathered from multiple original sources, there is no consolidated reference list. However, a comprehensive bibliography is being developed and will be available to those who sign up at www.HBCUSTEMhub.org website.

This Black Paper series will focus specifically on findings resulting from the collaborations established by the Analytic Hub, the outward facing research arm of the HBCU STEM-Undergraduate Success Research Center. Future White Papers and Blog posts will provide more detailed explanations of the topics described here. Ultimately, this body of work aims to support an increasing number of communities of practice that focus on Discipline Based Educational Research at HBCU's.

Linda Darling Hammond once remarked on the “pop-corn” nature of academic interventions; potentially impactful activities that are not sustained once the grant ends. In our view “popcorn” interventions are prevalent because many grant-supported intervention efforts are effective but not impactful. Efficacy can be measured by a change in a targeted parameter that is of interest to the researcher. However, we define impact as showing a direct or causal relationship with a student's course grade and gradual improvement in GPA. Our experience at VSU showed that **while all impactful interventions are effective, not all effective interventions are impactful**. Moreover, in order to replicate and scale impactful academic interventions, it is necessary to secure buy-in from multiple departments and administrative units to reach large numbers of students. Finally, for the impact to be sustained once the grant ends, there must be institutional commitment in the form of financial and human resources dedicated to

support the effort. However, it all starts with the first step—an investigator who has an idea to improve student outcomes. In our case, once the journey began, a theory guided further research questions and an assessment, based on the theory, informed the intervention. That story is told here.

USING PVEST TO LINK THEORY, ASSESSMENT AND PROGRAM ACTIVITY

PVEST AS A STARTING THEORY

For most stake holders involved in educational enhancement, an important goal is to improve persistence, retention and graduation rates; all of which are contingent upon grades. However, course letter grades are *lag measures*. They are awarded only after a myriad of small, antecedent behaviors or *lead measures* have been performed by the student over the course of weeks and sometimes months. Identifying these antecedent behaviors and helping students remain motivated to practice them for an entire semester became the focus of the intervention effort at Virginia State University, known as Project Knowledge.

In our experience, struggling students who adopt and maintain new academic behaviors will eventually get better grades. Therefore, we define **Academic Behavior Change** as the measurable trait(s) that the student expresses behaviorally as a result of changes in internal attitudes and/or beliefs. The changes in attitudes and beliefs are presumably the result of the student's participation in the intervention activities. A snapshot of these internal changes can be captured with a survey or with qualitative methods, like focus groups. This tells you that the intervention is having an effect. However, we believe that linking the intervention to measurable changes in academic related behaviors is the true test of the intervention's impact.

As described in Black Paper #1, *Why it works: Project Knowledge, a 10 year academic intervention*, the original Project Knowledge intervention focused on the near-peer mentor model- the relational bonding of a trained upperclass mentor and entering student mentee. PVEST provided an ecological systems approach that helped us to examine the impact of the mentor-mentee relationship on students' motivation to adopt and maintain sound academic habits. We hypothesized that the strength of the relational bond was key to new students adopting the behavior that was modeled by the older

students. Later we found that the mentor-mentee relationship was not as critical as was the context of the relationship. The mentoring relationship itself, required a community. Within this context, our findings revealed that the mentees experienced small successes that strengthened self-confidence. Over time, the self-confidence grew which led to improved self-efficacy. Eventually a sense of competency evolved in which the mentee continued to use the academic skills but no longer needed the intervention. This is what we called self-agency.

These three elements, self-confidence, self-efficacy and self-agency became the targets of the intervention's programming efforts. We discovered that other factors were at play, and so we learned to mitigate the effects of risk factors such as self-sabotage and negative self talk. We also added activities that promoted protective factors such as meta-cognition and self-regulation. It was the combination of all of these that helped students experience Academic Behavior Change that resulted in higher grades.

As the findings from Project Knowledge were shared with the larger campus community, the questions surrounding the intervention's impact shifted to whether the critical elements of acquiring academic skills, self-confidence and self-agency could be infused within other pre-existing interventions. A related question was "How could these critical elements be included in class room teaching?". Finally, we wanted to know how to successfully scale the activities so that the maximum number of students could be helped at a cost that could be absorbed by the University.

In order to answer these broader questions, we used PVEST to help identify specific classes of protective and risk factors and then designed programming elements that could target them. We also reasoned that PVEST would also assist in limiting the number of possible variables to those associated with grade improvement. Finally, we posited that if the student's risk and protective factors could be ascertained *a priori* by a qualitative assessment then it would be possible to design the intervention activities based on these data. A more customized type of intervention would better meet the needs of certain groups of students. Armed with this information we began developing a quantitative assessment instrument based on PVEST.

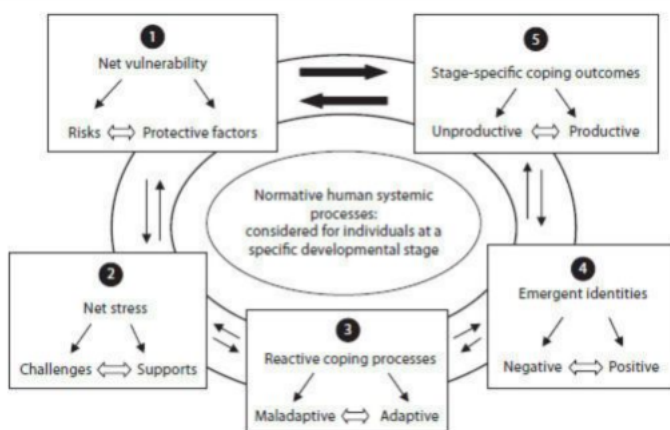
There are five stages in the PVEST model (see Figure 1). The first of the five stages (#1) allows for an identification of the student's vulnerabilities as seen from the student's own

perspective. In this stage we considered the heterogenous nature of the HBCU student population and identified personal characteristics and net vulnerabilities that could potentially influence a student’s reaction to academic stress. At VSU, a significant portion of our students are first generation college students. Therefore we knew from the literature that their naiveté could be a potential risk factor. Programming elements had to include not just how to learn in college classes but how “to do” college. Moving counter-clockwise, in stage #2, the model asserts that the stressor, in this case leaving home and entering the college environment is the stress engagement that will elicit coping behaviors that the student has used previously. These reactionary behaviors (stage #3) will either be adaptive to this new situation or maladaptive as defined by the outcome.

If the outcome is maladaptive, (for example, earning a low quiz grade and then skipping class to avoid seeing the professor) then by using the PVEST model you could determine if an intervention is more effective if occurring between stages #1 and #2 (addressing a net vulnerability) or stages #2 and #3 (training in new coping mechanisms).

The first option, addressing net vulnerabilities is most widely used. Here the focus is on the low quiz grade and usually entails tutoring and remediation. The second option addresses the response to the outcome rather than the outcome itself. Here the focus would be on training students to self-correct by engaging in help-seeking behaviors, like going to the professors office hours.

The theory posits that the emergence of a new identity (stage #4) is a result of repeatedly employing new adaptive coping mechanisms. Acting from this new set of behavior over a period of time will produce new coping outcomes as well as new opportunities which lead to the cycle repeating itself (stage #5).



This dynamic process of growth and change occurs within and across multiple levels or ecological systems of which every individual is embedded. These include the level of interpersonal relationships, such as family, peers and teachers; the neighborhood and community and the larger educational

Figure 1 From Spencer, 1995

system. Interventions can occur at any and all of these levels represent sources of protective and risk factors. Furthermore, there is a temporal dimensions of human development, as the type of interaction within each level changes over time.

In truth, a student’s academic performance is not just about the student because no student lives in a vacuum. Students exists within intersecting systems that influence their lived experience. Therefore, to fully understand the learner and what happened to cause a failing quiz grade, one must also consider the student’s experience and how it is perceived by the student and not the observer. This is known as the students perceptual field (see Figure 2).

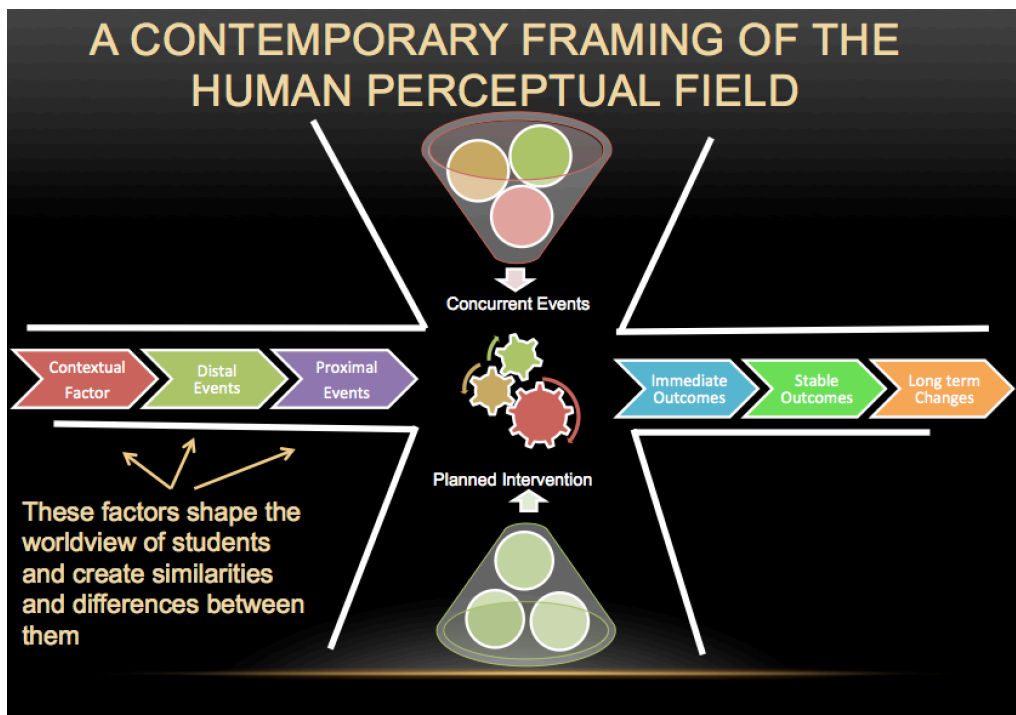


Fig 2 From the Analytic Hub webinar series, “Tea with Melvin Hall” Fall 2022.

The perceptual field is an attempt to capture the learner’s lived experiences; their perceptions of the immediate environments and contemporary events that are impacting the experience. The perceptual field of the student at any single moment is influenced not only by the distant past but also the immediate past and what has happened earlier today. This fact is not often considered when a quantitative assessment is given. Yet,

even small things, like lack of sleep or having missed breakfast could influence the result of an assessment.

However, even if a single survey were able to capture elements from the student's entire perceptual field, those perceptions could change the next day depending upon external events. Consider the impact of a student's perceptual field by events like the murder of George Floyd or of a Covid-related death of a loved one. Furthermore, just like no two students are alike, no two HBCU's are alike. The learning context: the relationship with faculty; the structure of the major; the campus culture could all impact how the student perceives themselves. Therefore, it is difficult to have one single impactful intervention model that will serve such a diversity of potential needs.

Since it is impossible to assess *all* of the elements associated with the perceptual field one strategy is to choose some elements to represent the different levels of influence. In other words, we could try to capture some elements within the perceptual field that are *representative* of the dynamic and multi-dimensional nature of the student's lived experience. This is what is known as *Representative Design* and was first discussed by psychologist Egon Brunswik in 1956. Brunswik asserts that the consideration of these influences is necessary for ecological validity. Thus, a goal of the Analytic Hub was to consider ecological validity as part of a broad assessment strategy.

We planned to begin this multi-step approach with first a focus on the individual student and then to continue to incorporate the influences of their learning environments over time. Other methods and additional partners would be necessary to help incorporate this expanding information. For instance Dr. Danielle Dickens created a qualitative assessment protocol aimed at assessing student-teacher interactions. Incorporating a mixed-method of qualitative and quantitative data would help better characterize students' perception of the learning environment. Additionally, other STEM-US Center partners, Rihanna Mason and Curtis Byrd developed THRIVE, an online database aimed at capturing information about HBCU campus culture. Their data offers valuable information about the heterogenous nature of HBCUs. Of course, this large data set would need expertise in data mining and so we thought that the Atlanta University Center Consortium's Data Sciences Initiative (www.aucenter.edu) would be a perfect partner as a data repository and to assist in ongoing analysis. Once gathered and secured the data could be used to employ more sophisticated data analytical tools and even new, more

inclusive theoretical models such as Active Inference. This larger research strategy has yet to be fully realized. However, the PVEST-informed quantitative assessment was the necessary first step toward this grand vision of gathering multi-dimensional information to assess ecological validity.

In the following section we will outline the of development of the STEM-US Assessment instrument. As stated earlier, the long-term goal is to create an assessment strategy that uses a combination of quantitative, qualitative and institutional data to create a dynamic profile of a successful HBCU student. We understand that even with this large and varied amount of data, we would still be interpreting it based on the perspective of a particular HBCU student, during a specific time period in their development. Still, in the aggregate, we believe the analysis could yield an understanding of the type of climate that fosters and sustains successful students at any specific HBCU.

THE IDENTITY RESEARCH CENTER ASSESSMENT (IRC)

What later became the HBCU STEM Undergraduate Success Center (STEM-US) began in 2018 as an outcome of a NSF research planning grant. One of the outcomes of that research effort was an assessment instrument known as the Identity Research Center Assessment (IRC). The IRC was initially designed by Dr. Amy Salter, then a graduate student from Georgia State University. Dr. Salter was asked by the project head, Dr. Curg Muldrow, a biologist at Morehouse College and PI of the STEM-US Center grant to draft an assessment as part of his research on Scientific Literacy. The Scientific Literacy intervention, designed by Dr. Muldrow and colleagues was a *virtual biology training modules aimed to increase scientific identity*. The web-based training platform had been used with entering Morehouse students and students at several public schools. The virtual modules provide students not only virtual biology lab experiences but also targets motivational skills, such as Growth Mindset.

Dr. Salter, whose training and degree was in educational statistics designed the instrument based on the variables that had been identified by Dr. Muldrow at that time and based on several years of his experience in implementing the Scientific Literacy intervention at Morehouse and in K-12 settings.

Prior to the submission of the HBCU STEM-US grant proposal, data was collected using this IRC instrument. The participants were drawn from 11 different HBCU's. Once the

Center grant was funded, Dr. Muldrow's efforts shifted to dissemination of the Scientific Literacy platform and the data set was given to the Analytic Hub to use as initial baseline data. As a result of funding from the Center grant, Dr. Chris Graziul, a statistician and associate of Dr. Margaret Spencer was asked to analyze the IRC data. The Center's first psychometric publication (Graziul, Salter Talley, 2021) focused on that analysis. Below are his emailed comments with emphasis given to statements pertinent to this present writing.

Dr. Graziul writes:

*"While the IRC Baseline Identity instrument provides novel insight into STEM identity among HBCU students, one of its major limitations is, ironically, its focus on students as the unit of analysis. By this we mean that students exist within a dynamic and constantly evolving system of relationships both prior to and during their time at HBCUs. **To fully understand STEM identity in this population thus requires the ability to identify, measure, and analyze the multiple, sometimes overlapping sources of stress and support that contribute to students' interest in and capacity to realize STEM-oriented career goals....."***

*"The contextual, interpersonal nature of these interactions suggests that, **to study STEM identity cultivation at HBCUs, it is important to supplement traditional psychometric evaluations with additional evaluative tools and data sources capturing the range of actors and contexts impacting identity formation among HBCU students.** These include (a) questionnaires distributed to STEM faculty whose goal is to understand both how faculty view their role as mentors as well as how institutions perceive their ability to support cultivation of STEM identity, (b) survey items whose goal is to capture students' prior experiences with STEM education as well as information about their learning environment, and (c) basic information about who is teaching STEM courses, their teaching load, and their availability to provide one-on-one support to students. Relevant information would also include STEM enrollment levels, formal/informal programs for supporting or encouraging" STEM engagement, and the availability of additional supports external to the institution (e.g. proximate STEM graduate programs).*

Based on the variables of interest that were targeted by Dr. Salter, the most meaningful PVEST-related constructs were not emphasized. (The meaningful PVEST-related

constructs were later revealed by STEM-US consultant Dr. Stephen Culpepper using a customized algorithm). However, one interesting result of the IRC analysis was the identification of “latent factors” that identified three distinct types of individuals among the participant pool from 11 different HBCUs. Additionally, the data revealed that Morehouse students were outliers in the data set, indicating a distinct but unidentified difference in that subsample. Despite the intriguing nature of the analysis, Dr. Graziul asserted that the assessment could not capture enough information from the student participants alone. **Therefore, initial findings from the IRC provided a new research direction for the Analytic Hub that called for examining student performance as a function of their personal characteristics within a learning context.**

Two other considerations emerged:

1. The original IRC had not been designed to examine the possible relationship between Identity formation and grade attainment/academic behavior change
2. The presence of latent factors that existed between and among the sample pointed to the usefulness of Person Centered Analysis as a method of reaching the Analytic Hub’s research goals.

Based on these conclusions, the assessment instrument that had been developed at VSU was considered to be more appropriate than the IRC.

The VSU instrument was initially designed specifically to elucidate motivational characteristics associated with first semester GPA of students attending a HBCU. The original name was the “Personal Factors that Influence Academic Behavior” assessment (PIAB). Our plan was for the PIAB to provide the foundation for a quantitative assessment that could be used Center-wide.

Although Dr. Muldrow has retired from Morehouse and from his position as director of the STEM-US Center, he continues his work with Scientific Literacy, along with colleague, Dr. Adrian Neely.

PERSONAL FACTORS THAT INFLUENCE ACADEMIC BEHAVIOR

Personal Factors that Influence Academic Behavior (PIAB) were first introduced as an inclusive term by graduate student, Stephen Scherer, now a practicing psychologist in New York. The term represented the group of non-content related or “affective” factors

that are associated with academic performance. The PIAB assessment included validated scales that measured cognitive-emotional regulation, time perspective, mindfulness, and self-regulation (Scherer, Talley & Fife, 2017).

PVEST served as a foundational theory in the development of the PIAB assessment instrument. PVEST was used to limit the broad range of possible factors to those associated with identity and emotional development. Initial findings revealed that time perspective, emotional regulation, and mindfulness were core target areas associated with first semester GPA. Specifically, Scherer Talley and Fife, (2017) found that future time perspective, past negative time perspective (catastrophizing), and cognitive-emotional regulation were significant predictors of first semester GPA..

Subsequent findings from the PIAB assessment highlighted the important relationship between cognitive-emotional regulation and academic success. Another graduate student, Tiwah Banjoko examined this relationship as part of her Master's Thesis. (Banjoko, Fife, Davis, Morrison, and Talley, 2020). Tiwah Banjoko who went on to obtain her Ph.D in clinical psychology under the guidance of one of my VSU colleagues, found a positive relationship between maladaptive cognitive-emotional regulation and self-handicapping. Her study found that for African American STEM students, self-blame, rumination, catastrophizing, and blaming others was related to purposefully employing behaviors that would negatively impact their college careers. Conversely, adaptive cognitive-emotional regulation skills like acceptance, positive refocusing, focusing on planning, positive reappraisal, and putting into perspective were not related to self-handicapping behaviors. Previous work at VSU identified self-handicapping to be negatively correlated with GPA for African American students. (Serpell, 2015).

Findings such as this (Banjoko, Fife, Davis, Morrison, and Talley, 2020), also confirmed Dr. Margaret Spencer's (2015) thoughts on the association between coping strategies and academic outcomes. The coping strategies represent the internal attitudes and beliefs that drive the outward academic behavior. Spencer's theoretical model pointed to areas in which interventions could be most effective in helping students form adaptive instead of maladaptive coping strategies when faced with the stressors of college. In other words, we learned from PVEST that **the role of an effective academic intervention was to augment a student's perceived protective factors and mitigate the perceived risk**

factors. The combined findings highlighted the nuances of affective factors and their complex relationship to academic behaviors and outcomes.

VSU students have taken the PIAB as part of an introductory Biology course practically every semester since 2018. The data set now includes responses from over 3000 students. Such a large data set allowed for the use of more sophisticated psychometric tools. The data was first analyzed using stepwise linear and hierarchical regression in order to determine significant predictors of first semester GPA (Scherer, Talley & Fife, 2017). This was followed by analysis using principal component factor analysis, linear regression and PROCESS modeling (Davis 2022) to examine the mediating or moderating effects of the identified characteristics and to assess STEM course performance trends. The model identified that acquiring Academic Skills and demonstrating Self Efficacy (an individual's belief in their own capacity to reach a particular goal) were directly related to GPA. We also found that the effect of Adverse Childhood Experiences has a moderating role in first semester GPA. (The significant influence of negative childhood experience re-emerged in later analyses).

While these findings were impressive, they were only indicative of students at VSU who were taking a course in which the 315 item assessment was an actual assignment. In order to test for generalizability of the findings it was necessary to use the assessment instrument at other institutions. However, in order to do that the instrument had to be shortened. How to reduce the number of items in a way that was psychometrically sound became the next challenge.

THE HBCU STEM-US ASSESSMENT

USING PSYCHOMETRICS TOOLS TO REDUCE THE NUMBER OF SURVEY ITEMS

One reason that the PIAB was so lengthy was that for each of the validated subscales used in the PIAB, the entire set of questions for that particular subscale had to be included. By removing particular survey items, the validity of the subscale was put at risk. That means that by removing individual items, it was possible to lose the connection to the variable of interest. What was needed was a way to shorten the assessment without cutting the link between the individual survey items and the variable that they were meant to identify. The strength of this connection depended psychometrically on means testing or the the average score that was provided by the surveyed students. However, it

was possible to use another method, Bayesian Analysis. Bayesian analysis could focus on the probability of the item being associated with a specific criteria, set by the investigator. This probability testing could be done without reliance on the entire subscale's association with the variable it was designed to identify. However, Bayesian analysis is a more sophisticated statistical analysis than what is normally used and required a high level of analytic and statistical expertise.

Fortunately, for us, Dr. Stephen Culpepper was available as a consultant to the STEM-US Center. Culpepper had developed an algorithm that could do just what was needed. Dr. Culpepper, was then an associate professor in the Department of Statistics at the Beckman Institute for Advanced Science and Technology University of Illinois at Urbana-Champaign and editor of the Journal of Educational and Behavioral Statistics. In his initial analysis, Dr. Culpepper used data from 786 VSU students who had answered 318 survey items that were sourced from 10 validated scales. His algorithm linked individual items to the most probable association with our outcome measure, first semester GPA. We identified first semester GPA and withdrawal from VSU during the first semester as the outcome criteria because most attrition occurs during the first three semesters. The algorithm identified 70 items out of the 315 that were associated with 3 factors that aligned with academic skill set, self-confidence and self-agency. In addition, low math anxiety was also identified as a protective factor and all of these were correlated with high first semester GPA.

A Bayesian exploratory factor model showed that the model predicted 6.9% of the variability in observed GPA. While not conclusive, **the findings indicated that a profile of a successful student could be produced by the pattern of student responses associated with those students that had a high first-semester GPA**, (see Figure 3). We considered this characterization of academic success to be grounded in the theoretical model provided by PVEST and therefore, the results were used to inform the intervention targeting entering students. This theoretically-based and data driven research focus continues at VSU in the form of a "boot camp" for academic mentors. In late 2023, students from several campus entities spent a weekend at Ft. Lee Army Base in Hopewell, VA. Our inaugural class of about 20 students experienced 22 hours of community building activities as part of the two day training. This new program, is a result of an IUSE Grant conducted with my dear colleagues in Biology, Drs. Leslie Whiteman and Brain Sayre. That program is currently training mentors to assist not only incoming freshmen

but students who are on academic probation. Thus Project Knowledge is informing the “Successful Transition to the Academic Realm- Integrated Academic Mentoring (STAR-IAM) with plans to become a standard means of campus mentor training.

NEW FINDING: ALGORITHM GENERATED PROFILE OF SUCCESSFUL STUDENT

It is not a sound psychometric practice to assume that the same characteristics that were associated with high performing VSU students would be true for all HBCU students. To confirm generalizability for the assessment, Dr. Culpepper suggested that we give the same 300+ survey to students from other HBUC’s. While this was the next logical step it was not practical, especially since many of our external faculty partners were not trained in social science research. So we decided to encourage the use of the assessment by first making it shorter and second by providing external partners incentives to engage in the research. We embarked on both tasks as part of a comprehensive research strategy that began to look beyond the student to the learning ecosystem.

Profile

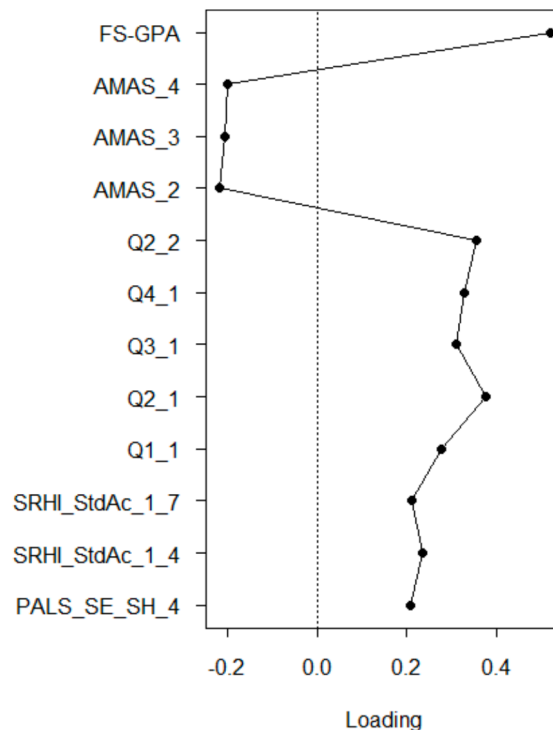


Figure: Profile of students with high first-semester grade point average.



Figure 3 From: Culpepper, S.A. (November, 2020) Understanding the link between the PIAB and academic outcomes, HBCU STEM-US Center Presentation. These findings show a negative association with math anxiety and a positive correlation with self-confidence, self-efficacy and self-agency in our sample. More information on Dr. Culpepper's analysis can be found on the Hub's website, www.hbcustemhub.org

While it was not an acceptable practice to randomly delete survey items, it was acceptable to use an expert to link the test items to a theory and then use the theory-derived associations to limit the number of survey items. This plan of action was executed in 2021 when Dr. Margaret Spencer, author of PVEST, along with her associate Dr. Christopher Graziul identified the much smaller list of survey items generated by the Algorithm as Risk or Protective Factors. Thus the current version of the STEM-US Quantitative Assessment Instrument continues to generate data that is conceptually linked to PVEST.

NEW FINDING: FAMILIES OF PROTECTIVE AND RISK FACTORS

At the 2022 Psychometric Short Course, Dr. Samuel West used Psychometric Networks to illustrate the influence of protective and risk factors. Network exploratory analysis of the same sample dataset used to reveal a successful student profile now revealed "families" of items that were most associated with specific risk factors (i.e., negative childhood experiences and maladaptive self-criticism) and protective factors (social support and perseverance)

Despite the fact that these findings were associated with college undergraduates, the intervention activities of Project Knowledge at Petersburg High School were also informed by the findings. Based on the exploratory analysis of the Psychometric Networks we better understood the importance of self-regulation and adaptive coping skills. We interpreted this to mean that if students are better able to control their own thoughts, then they will be better able to cope with academic stress. Based on this finding we introduced additional metacognitive and relaxation activities into our weekly programming,. In addition, an after school meal was provided along with increased programming on mental and emotional well-being since the risk network revealed factors that were associated with food insecurity and a history of familial mental illness,

Protective Network

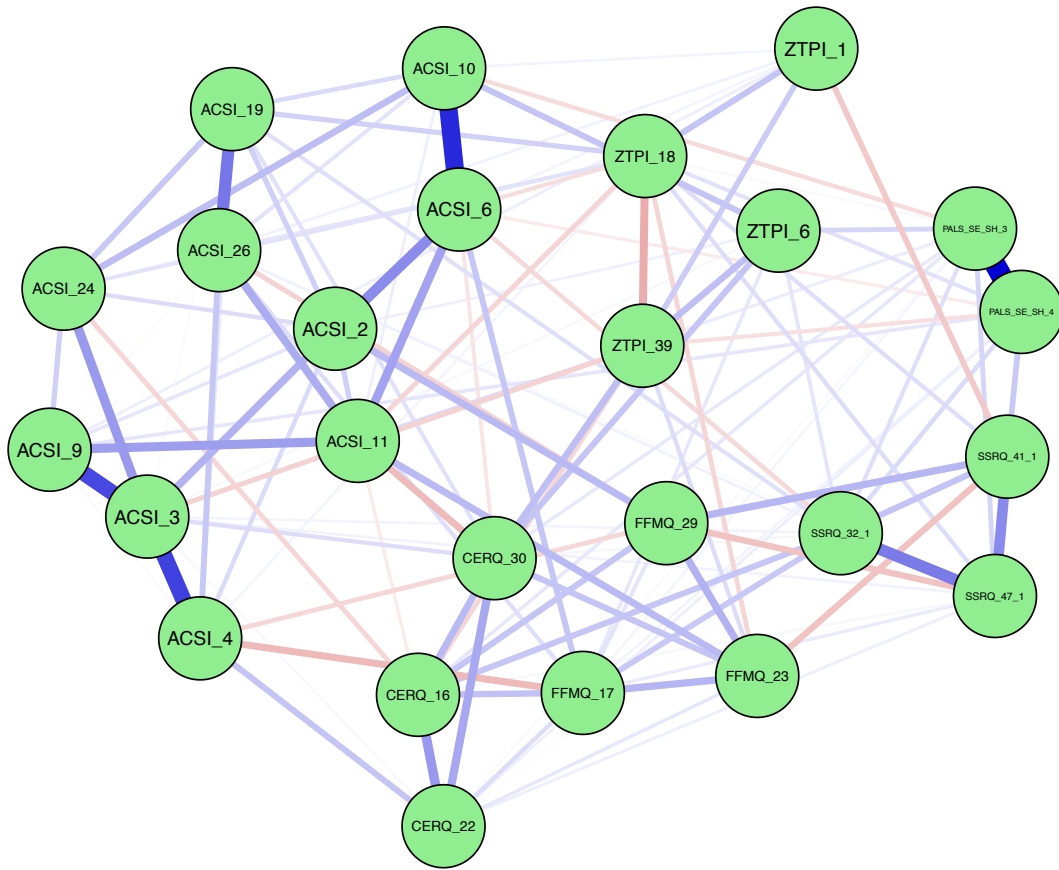


Figure 4 From: Kuno, C.B. West, S.A., Talley, C..P. (2024) Using Psychometric Networks to inform a campus intervention *Submitted*. The Protective Network revealed a positive correlation between Africentric coping skills and first semester GPA. More information on the Psychometric Network analysis can be found on the Hub’s website, www.hbcustemhub.org

Risk Network

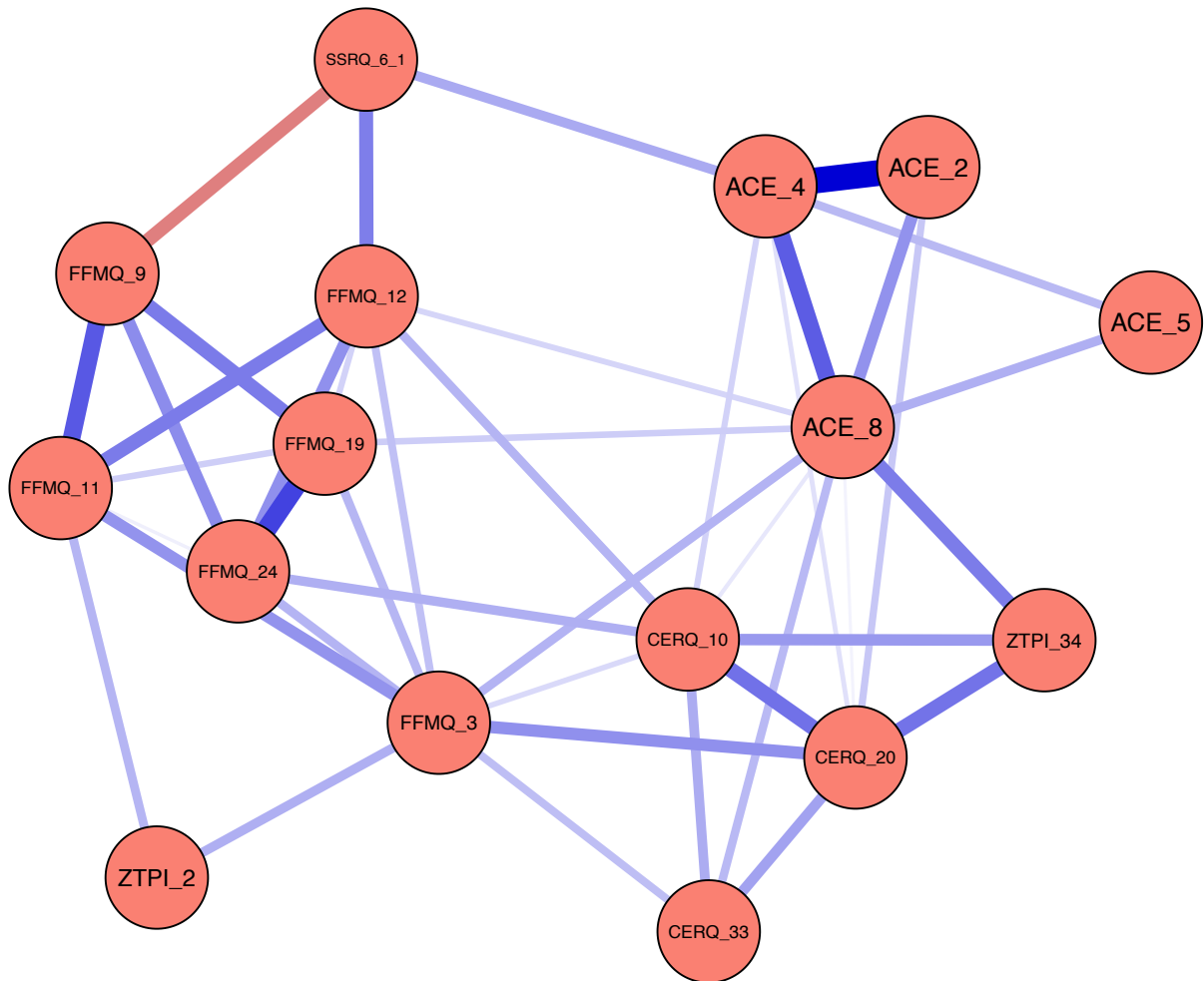


Fig 5 The Risk Network indicated that having a family member with a mental illness and having experienced food insecurity were negatively correlated with first semester GPA. More information on the Psychometric Network analysis can be found on the Hub’s website, www.hbcustemhub.org

VALIDATION OF THE HBCU STEM-US QUANTITATIVE ASSESSMENT INSTRUMENT

Finally, validation of the STEM-US Center Assessment was completed by Dr. Damon Bryant from Morgan State University (MSU). MSU is the only HBCU with a graduate program in psychometrics. Assisted by MSU colleague, Avis Jackson, a co-director of the Analytic Hub, Dr. Bryant has greatly contributed to the HUB’s research effort with his focus on the assessment instrument data and desire to utilize Artificial Intelligence (AI).

Dr. Bryant's work on the validation of the STEM-US Assessment was necessary to ensure that the assessment items were actually measuring the psychological construct as defined by the originators of the original scale. His use of a one-dimensional differential item functioning (DIF) analysis revealed that the scale's items were consistent in their link to their PVEST-inspired designations. Using ordinal logistic regression on each of PVEST dimensions, the analysis examined the composition of assembled items from the pre-existing scales. Overall results suggested that there was measurement equivalence across a number of PVEST labelled items. A Multidimensional DIF analysis suggested that more of the items showed evidence of measurement equivalence across the PVEST framework when conditioning on several subcomponents versus only one composite. The conclusion from the analysis is that operational definitions intentionally developed around the PVEST framework, do adequately measure the constructs and demonstrate some level of measurement equivalence.

As part of the Hub's Psychometric Community of Practice, Dr. Bryant has submitted an NSF grant proposal to further refine the STEM-US Assessment. The proposed grant activities seek to develop a hypothetical characteristic profile of a successful HBCU student from several HBUC's. In order to deploy the full assessment at several candidate HBCU's, this proposal seeks funding to improve and increase the most useful assessment items using linear equating methods under the nonequivalent groups with anchor test (NEAT) design. The specific aims of the proposed work will be: (a) create a set of automatic item generators to support PVEST constructs, (b) generate pools of items that can be assembled into parallel forms, which then can be administered across different HBCUs, and (c) establish measurement equivalence of generated items by administering the forms across a HBCU network of participating schools.

ASPIRING FOR ECOLOGICAL VALIDITY

This line of research has a big goal. We want to spur a new era of academic intervention research at HBCU's that will utilize Person-Centered Analysis and the power of AI to improve impact of academic interventions. We believe that by developing impactful interventions that can be replicated across institutions and scaled to meet the needs of our students, we may be able to address the COVID-related learning loss that is changing the nature of education. This grand goal will not come quickly nor can it come from a few isolated studies. This effort will require collaborations across multiple institutions and

also sustained funding. The research described here began in 2014 and has been continually funded for 10 years. Yet, **these findings would not have been possible without resources and support from the HBCU STEM Undergraduate Success Research Center.**

Project Knowledge is now informing Relational Learning and Mentoring and Teaching efforts across the VSU campus that will reach several hundred students. PK also has also birthed demonstration projects in one Virginia high school with plans for adoption at another district in North Carolina. The Hub's goal for a multi-institutional data repository won't be met during this current grant period. Others will need to create the methods and structures to support and sustain such a large scale effort. However, the HBCU STEM-Undergraduate Success Research Center has shown what is possible when HBCU faculty come together committed to a common vision and with faith, attempt what hasn't been done before. After all, that is what HBCU's have done since we began.

CONCLUSIONS

In summary, the ultimate benefit of having a profile of a successful first semester student would be the possibility of tailoring academic interventions to a specific target audience and eventually, with the help of AI, making predictions based on certain personal factors. The findings obtained from the studies outlined here are already informing campus-wide activities at VSU and activities beyond the campus

We now know that VSU entering students with high first semester GPA are more likely to:

- envision their end goal and future self and see their current activities as contributing to the end goal
- adopt, practice and maintain sound academic skills and be flexible when their current practices are not producing the desired result
- build self-confidence by identifying success at multiple points, not just final grades and also
- take ownership of their education by assuming responsibility for their learning.

- employ a metacognitive practice (i.e. journaling, meditation, prayer) to augment adaptive coping.

There is much left to learn about how to cultivate these and other strengths in all of the students that attend VSU. There are many challenges. For instance, we know from our data that a significant number of incoming students have experienced childhood hardships. The stress of the first semester may be enough to trigger coping responses that may negatively impact academic performance. Findings such as these have fueled the movement toward a more relational brand of student-centered teaching/learning. The goal will be to provide supportive relationships between faculty and students with student-centered pedagogy and also between upper class students and entering students through intrusive mentoring. Most importantly the target of an impactful PVEST-inspired, ecologically valid intervention will be the student's own perception of themselves. In that scenario, the intervention will provide a safe space for self-reflection and introspection.

Imagine if every intervention across your campus had elements that supported trusting, nonjudgmental relationships. Imagine every remediation effort creating spaces for students to admit their vulnerabilities and mistakes and then learn to learn differently. Finally, imagine a type of near-peer mentoring that will help the mentee to take full responsibility for their own learning; engage the mentors to experience themselves as change agents and encourage every teacher to fully embrace the noblest of professions.

You've just imagined the end of "pop-corn" interventions.

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