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Applying Performance Pyramid Model in STEM Education through Peer-led Learning Communities

Qingxia Li [1*], Thomas Gross [2] and Patricia McCarroll [3]
[1] Fisk University, Nashville, Tennessee, USA.
[2] Western Kentucky University, Bowling Green, Kentucky, USA.
[3] Fisk University, Nashville, Nashville, Tennessee, USA.
*Corresponding author email id: qli@fisk.edu

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Abstract **– While many studies have demonstrated the efficacy of programs designed to increase underrepresented minority participation, this article establishes a guiding theoretical model which examines why such programs might work. Theoretical models are often used to support curricular innovation by specifying guidelines for how to design new programs intended to broaden participation in STEM. The theoretical model of the Performance Pyramid was used as the foundation to develop intrusive Peer Partnership Learning (PPL) communities and develop a measure of student needs. The PPL communities were designed for students to simultaneously take College Algebra and General Biology I and involved weekly sessions led by trained PPL leaders to reinforce course content and work on biology projects with imbedded math content. The augmented SSNS (SSNS-A) was developed to measures these students needs that are directly related to the Performance Pyramid constructs. In addition, other outcomes measures were selected to identify, analyze and address the barriers to student performance in both courses related to the seven support systems of the Performance Pyramid. This theory-based program was developed to (a) advance and test pedagogical linkages between biological and mathematical concepts; (b) improve, test, and refine the assessment instruments, and (c) test the acceptability and efficacy of a fully integrated biology-math curriculum on student performance and attitudes.**

Keywords **– Peer Leaders, Peer Partnership Learning Communities, Performance Pyramid Model.**

I. Introduction

1.1 *Background*

Retention of African American students remains a prevalent problem within Historically Black Colleges and Universities (HBCUs). The Journal of Blacks in Higher Education (Research Studies, 2014) compiled a listing of Black/African American student six-year graduation rates for a large group of the nation's HBCUs. Only five HBCUs had a Black student graduation rate above 50%, and half of the HBCUs reported rates of less than 34%. These trends are also reflected in difficulties with retaining African American students in science, technology, engineering, and math (STEM) fields (Ma & Liu, 2017). Many incoming African American students display strong interests in STEM careers; however, many academically capable African American students are switching to non-STEM majors (May & Chubin, 2003). Research using theory-based models is needed to assess and address why high initial interest in STEM majors is followed by low persistence for African American students. In this paper, we propose an intrusive learning intervention as a theory-based method to enhance the academic performance and retention rate of African American students in STEM disciplines.

This intrusive learning intervention uses cross-course concept reinforcement through Learning Communities (LC) led by Peer Partnership Learning (PPL) leaders. That is, students are required to apply interrelated concepts across courses to complete targeted assignments. The PPL leaders in the LCs are important to develop supportive networks and provide opportunities to model personal development as a STEM student. VanOra (2019) conducted an interview with students in an LC and found that students' narratives clearly illuminate benefits from engaging with peers, drawing interdisciplinary connections, and participating in an active and collaborative construction of knowledge. Moreover, there is a body of research and professional literature that demonstrates the efficacy of collaboration between faculty and PPL leaders, particularly for learning communities, to increase retention in STEM (Minor, 2007; Astin 1996; Kuh, Kinzie, Schuh, Whitt, and assoc. 2005). We based the general learning intervention procedures on successful STEM learning communities. However, we have developed a measure and assessment structures to examine the theorized underlying factors that are purported to increase student academic performance and persistence to STEM education.

1.2 *Terminologies*

Intrusive learning is conceptualized as that the use of repeated mentor-mentee interactions to stem academic and personal difficulties in order for students to complete their degrees (Earl, 1998; Yarbrough, 2002; West & Williams, 2018). Within this paradigm the primary focus is on academic success (e.g., retention, test scores), where there are targeted instructional efforts to meet students' scholastic needs and to improve their motivation (Heisserer & Parette, 2002). Peer-mediated interventions that are manualized and directly related to academic needs could serve this purpose (Grandstaff-Beckers, Saal, & Cheek, 2013) and may promote retention through degree completion (Michael, Dickson, Ryan, & Koefer, 2010). Learning communities provide a structure for social interactions between and among students, PPL leaders, and faculty. The theoretical perspective undergirding learning communities is what Kenneth Tobin (2015) called a "sociocultural perspective." This perspective on learning highlights the social forces that affect learning, including how students learn with others, through others, and from others, as well as the importance of collective relationships and social networks to an individual's outcomes (Scott & Palincsar, 2014). A sociocultural theory of learning shifts from teacher-focused views of education to the interaction between teachers and students in learning activities. This theoretical framework has driven numerous pedagogical shifts in the university classroom, such as peer-assisted learning, problem-based learning, collaborative learning, and active learning (Bishop & Verleger, 2013; Jonassen & Easter, 2012).

1.3 *Institutional Needs*

Many students show an initial interest in biology-related fields when they matriculate to the participating south-eastern HBCU. Data from the office of admissions indicated that 35% of incoming students have an interest in the biology major, but less than 12% of graduates completed a degree in biology. This might be reflective of an often observed phenomenon where a large portion of biology students switch to non-STEM disciplines because they cannot complete the required math courses for upper level courses. Failure to understanding the concepts in college algebra has become a key issue for students to persist in STEM majors. African American students (Treisman, 1992), when compared to their international peers from the continent of Africa, were more likely to fail or barely pass required math courses in STEM fields when studying in isolation and detaching their academic lives from their social lives. In contrast, their international peers, who were more likely to achieve high grades in STEM, tended to form cohesive support groups that met consistently and expected high levels of pre-group preparation, which included study groups in math and other STEM courses. Belonging to a learning community could improve biology students' outcomes and retention rates by improving their self-efficacy in their chosen ST-

-EM field.

1.4 *Literature Review*

Research shows that individuals with high STEM self-efficacy perform better and persist longer in STEM disciplines relative to those lower in STEM self-efficacy (Bandura & Locke, 2003; Rittmayer, 2008). Self-efficacy beliefs may be developed through positively appraised task outcomes and environmental support, such as LCs. Self-efficacy beliefs are a primary piece of the performance pyramid and based on four primary sources of information: mastery experience, vicarious experience, social persuasion and physiological reaction (Bandura, 1997; Pajares, 2005), which are related in developing support systems. STEM-based LCs have been found to predict academic achievement and increase persistence rates (Carrino & Gerace, 2016; Kuh, 2008; Heaney & Fisher, 2011; Inkelas, 2012). LC participants earned higher GPA's than non-LC participants (Baker & Pomerantz, 2001), have higher graduation rates, report higher levels of satisfaction with college experience (Zhao & Kuh, 2004), have higher levels of academic self-confidence (MacPhee, Farro, & Canetto, 2013) and are overall more academically engaged (Rocconi, 2011).

Relatedly, STEM students in HBCUs may increase their work completion effort, participate more in class and have more positive engagement (i.e., enjoyment) and less negative engagement (e.g., discourage or worried) as self-confidence increases. HBCU students' feelings of comfort and acceptance within a STEM course promote effort and participation, and decrease negative engagement (Wilson et al., 2015). This fits well with the use of LCs, as they build a network for support and engagement with STEM course material, as well as require the development of self-efficacy by completing course work. It is then expected that as participation in a learning community continues, self-efficacy should increase and result in improved STEM course outcomes. For example, underrepresented minority students who participated in a one LC were more likely to persist in a calculus-based major (Murphy, Stafford, & McCreary, 1998).

1.5 *Objectives*

We developed a program that features an intrusive LC for College Algebra and General Biology I students with hopes that it would lead to increased retention and participation rates of underrepresented STEM students. Importantly, it addresses completing mathematics courses that are needed to participate in furthering their STEM education. The primary objectives of the intrusive LC include: (a) advance and test pedagogical linkages between biological and mathematical concepts; (b) improve, test, and refine the assessment instruments, and (c) test the acceptability and efficacy of a fully integrated biology-math curriculum on student performance and attitudes.

II. THE LEARNING COMMUNITY MODEL

Despite many efforts of government agencies and educational institutions to increase participation of under-represented groups in STEM disciplines (Hurtado, Newman, Tran, & Chang, 2010), some minority groups remain underrepresented (Malone & Barabino, 2008). Successful STEM programs (e.g., the Minority Engineering Program, the Meyerhoff Program; Tsui, 2007) use integrated approaches that include a variety of activities, such as financial support, faculty-student research and mentoring, recruitment, and supplementary education for underrepresented students. Indeed, an integrated approach is seen as necessary to achieve measurable success in broadening underrepresented minority participation in STEM disciplines (Maton & Hrabowski, 2004).

There are multiple causes of low STEM participation among underrepresented minority groups. Although poor educational preparation in math and science is certainly an issue, most authors (Maton & Hrabowski, 2004; Tsui, 2007) acknowledge broader causes of low participation in STEM disciplines that include psychological factors such as motivation. The need for a broader model of performance comes with the recognition that there is an ever-growing number of academically talented underrepresented minority students who choose non-STEM careers, while the number of underrepresented minority students in STEM disciplines proves intractable (Malone & Barabino, 2008). Given that HBCUs generally experience difficulties with retention and the participating institution has struggled to retain a significant portion of biology students, an intrusive learning practices program that incorporates peer-mediate elements was believed to be a viable intervention.

We believe that the LC approach reflects the fundamental theoretical foundations of the Performance Pyramid Model for African American students in STEM disciplines. Our intervention is framed in the Performance Pyramid theoretical model (Wedman, 2011) because the theoretical model has been successfully applied to educational settings (Wedman 2009; Wedman & Diggs, 2001; Wedman 2011). The Performance Pyramid proposes that there are six major support systems that affect STEM participation and persistence: (a) Knowledge and Skills; (b) Performance Capability; (c) Rewards, Recognition and Incentives; (d) Tools, Environments and Processes; (e) Expectations and Feedback, and (f) Motivation, Values, and Self-efficacy. Performance Pyramid support system framework is not hierarchical, but is meant to create a foundation of supports that will increase student success and retention in STEM disciplines (Wedman, 2011). Our strengths-based approach (Maton & Hrabowski, 2004) does not focus on remediating deficiencies among underrepresented minority students. Rather, we assume that underrepresented minority students have the potential for success in STEM disciplines if they are afforded the proper levels of support. The Performance Pyramid represents a way to conceptualize the students' foundational needs through the six support systems. It also provides a frame of reference for assessing if a program is working as intended and identify program strengths and deficiencies.

The PPL leaders lead small group sessions of one hour per week outside of regularly scheduled class time. The Students registered in the College Algebra and General Biology I courses concurrently and are divided into teams of five students. The teams of five students are assigned to one PPL leader. These small-group sessions are designed to help students develop effective study skills through practice with applied biology projects. The PPL intrusive LC intervention is a strategy to address the intersection of College Algebra and General Biology I course learning objectives. Students who participate in the LC are assigned mathematics projects and each assignment is led by PPL leaders. These projects are course content based applied projects related to the General Biology I Lab section. These projects are designed to integrate math into biology and take two one-hour sessions to complete.

We believe that providing a structured approach should reduce student stress. These intrusive LCs are designed to increase student achievement and motivation by creating a small group of learners who work on the course projects with collaboration and accountability. The PPL leaders could provide guidance for course work problem-solving and completion; whereas, peer-support is likely to normalize the academic and social skills learning process experienced by early college students. Moreover, all of these aspects are associated with better degree completion rates (Michael et al., 2010). Additionally, this intervention creates a need for the course faculty to maintain high levels of communication with PPL leaders for training purposes and students for progress monitoring and performance feedback purposes. This structure of interactions has been found to increase academic achievement and retention (Yarbrough, 2002). Each LC meeting will be structured to address core areas of the

Performance Pyramid (Table 1). The following subsections address how the LC meetings incorporate the Performance Pyramid elements.

2.1. *Knowledge and Skills*

During each weekly session, the PPL leaders review the key concepts in the General Biology I and College Algebra courses with all five students in their group, and connect the biology lecture material and lab skills with the underlying mathematics concepts. Then a biology-based, applied mathematics project is then completed by the group. The students complete the exercise independently between the first and second session for the unit, and then review the exercise with the entire group in the second session. Time is designated during each meeting to address concerns related to fundamental academic skills, such as study skills, note taking, time management, and approaching peers or professors for help. The PPL leaders establish a discussion board on the institutional online learning management system to encourage students to get to know each other, develop a sense of community, and exchange information regarding solutions to concerns about courses or between students and faculty. The online management system allows us to track the number of the times and durations students engage.

2.2. *Performance Capability*

The PPL leaders have students review and record their own scores on weekly assessments in a grade log, and participate in a short duration (≤ 10 mins) team building exercise. The PPL leaders have the students in the LC review places and characteristics of places that are optimal for studying and completing course assignments.

2.3. *Rewards, Recognition and Incentives*

Each week the LC projects are evaluated by the instructors and PPL leaders using the same rubric. The project with the highest score is selected as the best project and the LC group receives a badge recognizing the group as that week's winner in addition to extra credit points on their course grades. For each project completed, a student earns (a) one extra credit unit for attending the LC meeting, (b) two extra credit units for actively participating the group discussion, and (c) one extra credit unit for timely submission of completed projects.

2.4. *Expectations and Feedback*

The PPL leaders provide their respective LC students the information on exactly what they are expected to do to succeed in both courses. To assure faithful communication of expectations, the PPL leader review each syllabus for up-coming assignments with the students and have students affirm when the assignments are due and their plans for completion of the assignments in a stepwise manner. The PPL leaders have LC students fill in an individual grade log that includes assignments, quizzes, and exams after the students receive their scores. For each assignment, quiz, and exam, the PPL leaders have students set a "goal score" prior to completing the task. After the students receive their scores they compare the goal score to the achieved score. The PPL leaders offer individualized feedback on how to perform better on academic tasks (e.g., exams).

2.5. *Tools, Environment and Processes*

The PPL leaders provide LC students informational resources including study guides, online tutorial videos, and other supporting materials related to the intersection of the General Biology I and College Algebra courses. The physical location of LC space has white boards, comfortable chairs, and desks that are suitable for both individual and group learning activities. The courses are developed to provide complementary lessons across biology and mathematics. The PPL leaders serve as catalysts for student discussions that emphasize the quantitative elements of what they are learning in Biology from the assigned co-curricular projects, which act to supplement in-class instruction. The PPL leader meet monthly with faculty members to provide information regarding student support needs.

2.6. *Motivation, Values and Self-Efficacy*

The PPL leader have students rate their desire (1 to 5; 1 = *almost never*, 5 = *almost always*) to (a) continue to learn biology, (b) continue to learn mathematics, and (c) report if they can identify one STEM role model or person. The PPL leader will have students rate their perceived skill level (1 to 5; 1 = *completely disagree*, 5 = *completely agree*) for biology and mathematics, respectively. The PPL leader have the students write two things they have learned regarding the relationship between biology and mathematics. These items are included on a brief "check-in" questionnaire that is given after each project is completed.

Table 1. Learning Community Procedures Based on Performance Pyramid Elements within the Intervention.

Procedure	**Performance Pyramid Element**	**Time (Minutes)**
Learning Community Meetings		
Learning Community Two-Week Project - Week 1		
[a] Check-in questionnaire	Motivation, Values and Self-efficacy	5
Check use of Course Performance Logs	Performance Capability/ Expectations and Feedback	5
Team building exercise	Performance Capability	10
Review places to study/complete work	Performance Capability	5
Review Biology/Mathematics Key Concepts	Knowledge and Skills	15
Connect Biology/Mathematics Key Concepts	Knowledge and Skills	20
Expectations/Syllabus Review & Goal setting for up-coming course requirements	Expectations and Feedback	5
Learning Community Two-Week Project - Week 2		
Check use of Course Performance Logs	Performance Capability/ Expectations and Feedback	5
Applied Biology Group Project	Knowledge and Skills	40
Academic/Social/Cognitive Skill Topic	Knowledge and Skills	5
Expectations/Syllabus Review & Goal setting for up-coming course requirements	Expectations and Feedback	5
[a]Check-in questionnaire	Motivation, Values and Self-efficacy	5
	Total Time	120
Adjunct Activities		
Weekly Project Evaluation	Rewards, Recognition and Incentives	

Procedure	Performance Pyramid Element	Time (Minutes)
Attendance Tracking	Rewards, Recognition and Incentives	
Informational Resources	Tools, Environment and Processes	
Meeting Room	Tools, Environment and Processes	
PPL leader-Faculty meeting	Tools, Environment and Processes	
Note. [a]1st week and then after each two-week project is completed.		

III. Methodology

3.1 *Hypotheses*

When we established the LCs, we sought to test multiple hypotheses. (H1) We estimated that students in the PPL lead Learning Community will demonstrate greater knowledge and skills in their biology and math coursework than students participating in control conditions. (H2) We predicted that the conceptual elements of the Performance Pyramid can be quantified and items can be developed to reflect each aspect on student-report and observational assessment instruments. (H3) We also predicted that students in the PPL will have greater scores on a performance pyramid assessment. We have yet to finish the LC intervention data collection, so we cannot speak to the support of the first or third hypotheses, yet. However, we did complete a pilot of an augmented Performance Pyramid measure. In the following sections we provide an overview of our target students and measures used to assess student needs and performance.

3.2 *Participants*

The Learning Community in this project is solely focused on College Algebra and General Biology I at the participating HBCU. Participants consist of five PPL leaders, selected from STEM majors who completed College Algebra and General Biology I with a grade of "B" or above. Participants also include students co-registered in both courses. A control group at the HBCU is comprised of students convenience sampled from the same biology and college algebra courses. The control condition students receive the same courses, but without the added LC.

3.3 *Measures*

Augmented Student Support Needs Scale (SSNS-A)

The SSNS-A was an adaptation of the previously developed Student Support Needs Scale (SSNS; Hardy & Aruguete, 2013), where the items from the SSNS were used and new items were added in an attempt to create a more robust measure of the Performance Pyramid factors. The SSNS-A has seven scales with five items each: (a) Knowledge, (b) Performance, (c) Motivation, (d) Tools/Environment, (e) Feedback – Procedural, (f) Feedback - Rewards, Recognition, and Incentives (Feedback-RRI), and (g) Self-efficacy. Items were rated on a six-point scale (1 = *Strongly disagree* to 6 = *Strongly agree*). Higher scores on the scales of the SSNS-A indicate a greater presence of the performance pyramid structures. Mean item scores are computed for each scale.

After a pilot study with 78 students at the HBCU (15% of the student population), a series of procedures were used to determine if a 70-item version of the SSNS-A could be shortened and yield similarly viable scales (see Gross, Li, & Lockwood, 2019). The resulting 5-items per scale (35-item) version demonstrated adequate psychometric qualities, therefore it was used for this program.

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Subjective Science Attitude Change Measures (SSACM)

The SSACM was designed to assess the extent that students perceive an educational program brings about positive changes in in their science motivation, confidence, knowledge, and relationships with other science students (Deemer et al., 2014). The SSACM consists of 23 items, which use a seven-point rating system with three explicit 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. Increased science motivation measures instructional impact on students' perceived motivation for science. Increased science confidence measures instructional impact on students' perceived science confidence. Increased science knowledge measures instructional impact on students' perceived scientific knowledge. 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. Higher scores on the scales of the SSACM indicate increased motivation, confidence, knowledge, and social networks, respective to the scales. Mean item scores are computed for each scale.

Situational Motivation Scale (SIMS)

The SIMS measures aspects of academic motivation for college students (Guay et al., 2000). It consists of 16 items that are rated on a seven-point rating system, where students were asked to rate how well each item corresponds to why the student is engaged in a subject area courses (1 = *corresponds not all*; 2 = *corresponds a very little*; 3 = *corresponds a little*; 4 = *corresponds moderately*; 5 = *corresponds enough*; 6 = *corresponds a lot*; 7 = *corresponds exactly*). The SIMS has four scales: (a) Intrinsic motivation, (b) Identified regulation, (c) External regulation, and (d) Amotivation. Intrinsic motivation indicates if a student finds the course work engaging and interesting. Identified Regulation indicates if a student engages in the course work because it is thought to be personally relevant. External regulation indicates if a student engages in the course work because of coercion. Amotivation indicates if a student fails to find value in the course work. Higher scores on the scales of the SIMS indicate increased interest, relevance, sense of coercion, and loss of value in the course work, respective to the scales. Mean item scores are computed for each scale.

Math Barriers Scale - Math Anxiety (MBS)

The MBS measures anxiety related beliefs related to barriers for completing math course work (Hendy et al., 2014). The MBS has eight items, which are rated on a five point rating scale (1 = *almost never*, 2 = *rarely*, 3 = *sometimes*, 4 = *often*, or 5 = *almost always*). Higher scores indicate a greater presence of math anxiety. Mean item scores are computed for this scale.

Marlowe-Crowne Social Desirability Scale - Short Form (MC)

The MC is a 13-item short form of the 33-item Marlowe-Crowne Social Desirability Scale (Reynold, 1982). The MC uses self-report to assess the desire to conform to low frequency, yet highly desirable social behaviors. Items are rated as either *true* or *false* and are scored as 0 or 1, respectively. The items scores are summed and a higher score indicates more willingness to conform to conform to social rules and conventions, whereas a lower score indicates a greater willingness to answer truthfully regardless of social approval. Scores can range from 0 to 13.

Knowledge Tests

The primary outcomes measures for the program are separate biology and math quizzes that have items directly related to the College Algebra and General Biology I courses' content, respectively. Each quiz has 20 multiple choice terms and is worth 100 points. Students complete the quiz before they start the courses and after they complete the courses for the semester.

3.4 *Design of the Intrusive Learning Intervention Evaluation*

We are using a quasi-experimental non-equivalent control group design. Students are assigned to one of two groups, (1) the intrusive instruction PPL LC (treatment) or (2) traditional instruction (control). Students in the treatment group are registered in the LC and are required to attend LC meetings one hour a week and complete the LC projects with PPL leaders as part of their course requirements. Students in the control group attend traditional sections of General Biology I and College Algebra that will be offered during the same semesters. Students in the control group attend either General Biology I or College Algebra, therefore there are two control groups with one for biology and one for math. All courses are taught using the same assessments and textbook. We administer all measures to the students in the LCs and in the control groups. A Mathematics Anxiety survey at the beginning and end of the semester for the treatment and both control groups.

While we believe that this LC program will improve student academic performance and address their needs, we do need data to either support or refute this claim. That is, the LC intervention is intended to increase performance in biology, as well as deepen learning in College Algebra and General Biology I by relating math to biology via projects and peer-mentoring. However, we hope that it will also address social factors that leads to departure from STEM disciplines, namely, self-efficacy in preparedness for the required math knowledge.

IV. THE OBJECTIVES

STEM programs have used theoretical models to develop success and retention programs, this includes biology programs. In general, programs have reported favorable results. Nonetheless, broader assessments of student success, support, engagement, and responsiveness have not been collected. However, the elements of this LC model and the assessments used were selected to provide a broader spectrum of services and assess if the LCs promote academic and social support. While there might be potential benefits to biology and STEM education, this model has limitations that we will address, as well.

4.1 *Linkage between Biology and Mathematics Courses*

The first of the three primary objectives is to further development and testing of pedagogical linkages between biological and mathematical concepts. The current LC model addresses the first objective by linking a specific biology course to a corresponding mathematics course. In this model, the course instructors work collaboratively to develop assessments of knowledge and skills for use across treatment and control groups, as well as specifically for the LCs. The most noteworthy advance here would be to align learning objectives in the biology course with a math course that provides foundational knowledge and skills. That is, students have the opportunity to apply and generalize discipline specific math skills as they are acquired.

Linking course content might be useful for overlapping content across biology and math programs. However, there is likely multiple manners that colleges or universities sequence or overlap related mathematics and biology courses. Simultaneously providing the courses could interfere with already developed plans of study or approved course sequences for some schools. For other schools, where the courses could be offered in the same term, high teaching loads or other faculty obligations could make it difficult for collaborative course planning. It might be necessary for universities to provide relief from other responsibilities during a planning period in order to adopt this model of corresponding courses. These could include reduced course load or service responsibilities.

4.2 *Assessment Development*

The next objective is the development, testing, and refinement of assessment instruments. The assessment instruments include a variety of outcome measures that include course specific knowledge and skills, cross course knowledge and skills, and measures of perceived social support. This LC model provides the faculty an opportunity to develop interrelated course materials as well as collect data to determine if the assessments are allied to targeted course learning objectives. Additionally, the LCs will be used to assess the six elements of theory-based performance pyramid model. This is an opportunity to develop and refine a previously assembled performance pyramid assessment, where the constructs and there associations can be measured. Further, the correspondence of the performance pyramid element scales will be assessed across other self-report measures (e.g., motivation measures and math anxiety measures) and measures that are more objective (e.g., standardized scores, course assessments, grade point average). This allows for understanding how the theorized performance pyramid elements correspond to the experiences of the students.

The development of new assessments of math and biology knowledge and skills could be beneficial for helping students correspond the content in one course to the other. Moreover, the projects in the PLCs could make the connections especially salient. One caveat could be that theses assessments are develop narrowly for the courses at the university. This could limit their use across programs or universities and some attention should be given to universally accepted connections between math courses and biology courses. In consideration of the performance pyramid measure (i.e., SSNS-A), the development process has occurred at a relatively small HBCU. This could make generalization limited across other HBCUs, as well as universities in general. Special consideration should be given to understanding if the measure assesses different perspective on the performance pyramid elements.

4.3 *Examining Acceptability and Efficacy of an Integrating Biology-Math Curriculum*

The third objective is testing the acceptability and efficacy of a fully integrated biology-math curriculum on student performance and attitudes. The authors hope that our design will allow us to understand what the actual effect of the LCs is for the biology students. Moreover, we are taking social validity data to assess what benefits the students perceived from the LCs.

Still, the experimental design does not allow for random assignment, and issues related to self-selection and equivalency between groups will need to be addressed and considered in any analyses. Moreover, student perceptions of LC acceptability might vary based on multiple factors. These include LC leader characteristics and rapport building skills, time of administration (i.e., around finals vs. week 1), and intra-individual characteristics (e.g., receptiveness to feedback).

V. Conclusion

We used the theoretical model of the Performance Pyramid to develop and create a process for testing a LC intervention, as well as develop a psychometrically sound instrument to measure constructs directly related to the

Performance Pyramid. There are foreseeable uses for both the LC intervention and newly developed instrument, the SSNS-A. That is, universities could use them for college algebra and biology courses to assess and address barriers to student performance and retention related to academic and social support needs. The current contributions include linking course objectives between biology and math courses, developing an assessment of the Performance Pyramid theoretical factors, and identifying multiple potential assessments to identify STEM student needs at HBCUs. While we are using a quasi-experimental design to test the efficacy of PPL LC model, we believe the processes and eventual outcomes will be helpful for others to appraise what practices might to might not work to improve STEM outcomes.

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AUTHOR'S PROFILE

Qingxia Li, PhD, is an Associate Professor in Mathematics at Fisk University in Nashville, Tennessee. He obtained his PhD in Applied Mathematics at Louisiana State University in 2010. Before he joined Fisk in May 2014, he was an Assistant Professor at Lincoln University from 2010 to 2014. His research expertise lies in Applied Mathematics and Mathematics Education. He was selected as an Emerging Scholar by Diverse Issues of Higher Education in 2019.
email: qli@fisk.edu

Thomas J. Gross, Ph.D., is an assistant professor of psychology at Western Kentucky University. He received his doctorate in Educational Psychology, option in School Psychology. He has experience providing behavioral and educational services in school, community, and higher education settings. His research interests include evaluation of program implementation and efficacy, outcomes measurement, and assessment development. Other interests include math interventions and school psychologists' preparedness to work with diverse groups. email id: thomas.gross@wku.edu

Ms. Patricia McCarroll is an instructor in Biology at Fisk University in Nashville, Tennessee. She has been teaching biology courses at Fisk University for more than 40 years. Ms. McCarroll was constantly rated by students as one of their favorite biology professors on campus. email id: pmccarro@fisk.edu