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UNLOCKING THE GATE

UNDERGRADUATE TEACHING ASSISTANTS AND GATEKEEPER MATHEMATICS COURSES IN THE HISTORICALLY BLACK COLLEGE AND UNIVERSITY SETTING

DESTRANCANDO O PORTÃO

Assistentes de ensino de graduação e cursos de matemática porteiros no cenário universitário e universitário historicamente negro

DESBLOQUEO DE LA PUERTA

Asistentes de enseñanza de pregrado y cursos de matemáticas de guardián en el entorno universitario y universitario históricamente negro

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ABSTRACT

Mathematics continues to be a gatekeeper in limiting participation in the sciences especially among underserved, underrepresented, and racially minoritized students. The contribution of Historically Black Colleges and Universities (HBCUs) to broaden the participation of racially minoritized students in science, technology, engineering and mathematics (STEM) in the United States is significant. This paper reports the findings of a quasi-experimental study on the use of undergraduate teaching assistants (UTAs) in gatekeeper mathematics courses in the context of an HBCU. UTAs were assigned to gatekeeper mathematics courses to disrupt the individualized and deficit-oriented milieu commonly associated with learning mathematics. A total of 1,188 undergraduate students of African descent completed an end-of-semester survey on the use of UTAs in gatekeeper mathematics courses. Results reveal evidence of significant and positive effects of UTA use in gatekeeper mathematics courses on student outcomes. The significant positive results are attributed to the comparative proxies of UTAs who shared similar race and ethnicity with students enrolled in gatekeeper

mathematics courses. The significant results of UTA use in gatekeeper mathematics courses bode well for meaningful and practical application to HBCUs and other similar higher education settings seeking to increase STEM outcomes for students of African descent.

Keywords: gatekeeper mathematics courses. introductory undergraduate mathematics courses. undergraduate teaching assistants. historically black colleges and universities.

RESUMO

A matemática continua a ser um guardião na limitação da participação nas ciências, especialmente entre os estudantes carentes, sub-representados e racialmente minoritários. A contribuição das Faculdades e Universidades Historicamente Negras (HBCUs) para ampliar a participação de estudantes racialmente minoritários em ciência, tecnologia, engenharia e matemática (STEM) nos Estados Unidos é significativa. Este documento relata os resultados de um estudo quase experimental sobre o uso de assistentes de ensino de graduação (UTAs) em cursos de matemática de gatekeeper no contexto de uma HBCU. As UTAs foram designadas a cursos de matemática de porteiro para perturbar o meio individualizado e deficitário comumente associado ao aprendizado da matemática. Um total de 1.188 estudantes de graduação de origem africana completaram uma pesquisa de fim de semestre sobre o uso de UTAs em cursos de matemática de gatekeeper. Os resultados revelam evidências de efeitos significativos e positivos do uso de UTA em cursos de matemática de gatekeeper nos resultados dos alunos. Os resultados positivos significativos são atribuídos aos substitutos comparativos de UTAs que compartilharam raça e etnia semelhantes com estudantes matriculados em cursos de matemática de porteiro. Os resultados significativos do uso de UTA em cursos de matemática de gatekeeper são um bom presságio para aplicação prática e significativa em HBCUs e outros ambientes similares de ensino superior que buscam aumentar os resultados STEM para estudantes de descendência africana.

Palavras-chave: cursos de matemática porteiro. cursos introdutórios de matemática de graduação. auxiliares de ensino de graduação. faculdades e universidades historicamente negras.

RESUMEN

Las matemáticas siguen siendo un guardián en la limitación de la participación en la ciencia, especialmente entre los estudiantes marginados, subrepresentados y pertenecientes a minorías raciales. La contribución de los colegios y universidades históricamente negros (HBCU, por sus siglas en inglés) a la expansión de la participación de estudiantes de minorías raciales en ciencia, tecnología, ingeniería y matemáticas (STEM, por sus siglas en inglés) en los Estados Unidos es significativa. Este documento informa los resultados de un estudio cuasiexperimental sobre el uso de asistentes de enseñanza graduados (UTA) en cursos de matemáticas gatekeeper en el contexto de una HBCU. Las UTA se asignaron a cursos de matemáticas de guardianes para interrumpir el entorno individualizado y deficitario comúnmente asociado con el aprendizaje de las matemáticas. Un total de 1.188 estudiantes de pregrado afrodescendientes completaron una encuesta de fin de semestre sobre el uso de UTA en cursos de matemáticas gatekeeper. Los resultados revelan evidencia de efectos significativos y positivos del uso de UTA en cursos de matemáticas gatekeeper sobre los resultados de los estudiantes. Los resultados positivos significativos se atribuyen a los sustitutos comparativos de las UTA que compartían raza y etnia similares con los estudiantes inscritos en cursos de matemáticas para conserjes. Los resultados significativos del uso de la UTA en los cursos de matemáticas de gatekeeper son un buen augurio para la aplicación práctica y significativa en las HBCU y otros entornos de educación superior similares que buscan aumentar los resultados de STEM para los estudiantes afrodescendientes.

Palabras clave: cursos de matemáticas gatekeeper. cursos de introducción a las matemáticas de pregrado. auxiliares docentes de pregrado. colegios y universidades históricamente negros.

Purpose

Mathematics continues to function as a gatekeeper in the sciences especially among underserved, underrepresented, and racially minoritized students (Levya et al., 2021; Thompson, 2022; Fletcher et al., 2023). The contribution of historically Black colleges and universities (HBCUs) in broadening the participation of racially minoritized students in science, technology, engineering, and mathematics (STEM) in the United States is significant (Sampson, 2023). Drawing upon the historic mission and rich cultural experience of HBCUs, this paper reports the findings of a study on the use of undergraduate teaching assistants (UTAs) in gatekeeper mathematics courses to increase learning outcomes for undergraduate STEM majors at Lincoln University, an HBCU in the mid-Atlantic region of the United States. While part of a larger study, the focus on mathematics is purposeful given its central prerequisite role for students to matriculate as STEM majors. Reflective of the equity and social justice ethos of HBCUs (Franklin, Younge & Jensen, 2023), Lincoln University affirms the importance of Black identity and community wherein STEM majors have likened the context to an environment that feels like family (Mitchell & Fashola, 2021). Despite the supportive environment, performance outcomes in mathematics have persistently lagged behind introductory coursework in other fields required for STEM majors. Students of color are often subjected to racialized mathematics experiences which stigmatize learners, especially those of African descent, with stereotypical messaging, negative experiences, and microaggressions beginning in the precollege schooling context and continuing in the postsecondary setting (Martin, 2019; Davis, 2022; Roberts & Almeida, 2023). To counter the deficit-oriented narratives associated with learning mathematics as experienced by students of African descent, this study strategically deployed UTAs to gatekeeper mathematics courses. The use of UTAs can be regarded as a form of peer learning, widely used in higher education and defined as "the acquisition of knowledge and skills through active help and support among status equals or matched companions" (Topping, 2005, p.631). Information about the role of UTAs along with their recruitment and the selection process is described below.

Lincoln University received a $2 Million grant from the National Science Foundation to conduct the *Lincoln's Excellent Academic Program in Science – Transformation (LEAPS-T)* designed to increase the recruitment, retention and graduation rates of STEM majors (Chikwem, 2016). The gender balance of undergraduate enrolment at Lincoln reflects 66% females and 34% males; students' racial and ethnic demographics are 85% Black or African American, 6% Hispanic/Latino, 3% two or more races, 3% non-resident noncitizen, 2% race/ethnicity unknown, and 1% white (NCES, 2022).

Theoretical Framework

In this study, the UTAs functioned in a collaborative role attending to the potential of students enrolled in gatekeeper mathematics courses. The UTA Coordinator held training sessions for all UTAs prior to their assignment in mathematics gatekeeper courses to support their understanding of serving in a collaborative role to fulfill their responsibilities. The coordinator was well-versed in training methodology in support of peer learning through previous STEM-intervention efforts supported by the National Science Foundation. The collaborative element of UTAs in focusing on student potential to master the subject material would thereby lead to successful student learning in gatekeeper mathematics courses.

We used the proxy model of social comparison based on the Theory of Social Comparison for Self-Assessment of Ability for the theoretical framework (Wheeler, Martin & Suls, 1997; Suls, Martin & Wheeler, 2002) as it aligns well with the collective community context of HBCUs. Recent research shows racialized minorities switch out as STEM majors at higher rates than their white peers, despite

having similar proportional interest in STEM upon college entry and controlling for students' prior secondary academic performance and socio-economic status (Riegle-Crumb, King & Irizarry, 2019). Students begin to self-assess their participation early as undergraduates determining whether they can "cut it" as STEM majors. The Theory of Social Comparison for Self-Assessment of Ability asserts that individuals constantly engage in assessing their own capabilities and potential in comparison to others in social proximity, and proxies serve as legitimate and effective self-assessment mechanisms for social comparison.

A social comparison proxy in the form of a UTA is similar to the function of a role model, shown to be particularly important for STEM retention of underrepresented students (Atkins et al., 2020; Gladstone & Soto, 2021). Having recently completed the same course and sharing similar racial and ethnic demographics, the UTAs in this study represented realistic and relatable proxies of comparison, able to identify with the background, culture and experience of students enrolled in gatekeeper mathematics courses. Proxy comparison with close affinity as STEM majors of similar race, ethnicity and culture would evoke a comparative affirming realization for students enrolled in gatekeeper mathematics courses to identify with their UTA (i.e., "If s/he can do it, then I can do it too") and allow them to gain greater perspective and confidence about their capability to successfully persist and remain in STEM. The affirmative and aspirational mission of HBCUs in educating students of African descent (Rankins, 2019) coupled with the cohesive nature of the STEM community at Lincoln University mitigates the potential of a meritocratic narrative in damaging the agency of racialized minorities as often experienced in a Predominantly White Institution (PWI) (Gasman & Nguyen, 2019). The strong mission of HBCUs to focus on the educational promise and advance of students of African descent contributes to fostering a sense of collective pride among students (Cook, 2022) and the opportunity to learn in an environment conducive to proxy STEM comparison due to the positive racial socialization of students of African descent inherent in the HBCU experience (Freeman et al, 2021).

The Research Study

This quasi-experimental study focuses on the use of UTAs in gatekeeper mathematics courses to effect positive student outcomes. A pilot was conducted in the spring semester of the project's first year (Spring 2017). Full implementation of UTAs continued each academic year (AY) thereafter until grant expiration in 2020.

The primary role of the UTA was to support the teaching and learning experience in gatekeeper courses to improve student success. As such, they were the first line of defence in the mission to improve passing rates and student retention. The UTA Coordinator, a STEM faculty member at Lincoln University, was responsible for recruiting students and requesting recommendations from mathematics faculty as part of the recruitment process. Due to the cohesiveness of the STEM community on campus, the UTA Coordinator knew most of the upper-level students majoring in STEM from other STEM-related activities (e.g., annual research fair, STEM student clubs). Students had to submit an application to be considered as a UTA and also had to either complete an interview or have a faculty member submit a recommendation on their behalf. Students were recruited directly by the UTA Coordinator and by faculty, as well as through word of mouth by students who had heard about the opportunity or had already applied. A GPA of 3.3 or above, and an interest in supporting other students in STEM, were also requirements for the UTA position. The UTA Coordinator, in consultation with a team of STEM faculty, selected the UTAs. Assignment of UTAs to specific mathematics gatekeeper courses was completed by the UTA Coordinator based on prior performance in the course and compatibility fit with the instructor. Performance in the mathematics sequence for the TA-assigned course was also factored into making UTA course assignments.

A manual provided further guidance on the role and function of UTAs in working effectively with faculty and students. The manual also served as a reference for faculty on the appropriate role of UTAs. Each UTA signed an agreement of mutual expectations to provide some level of performance accountability. Each semester, UTAs held weekly peer-to-peer 10-hour study sessions. They planned weekly meetings

with the course instructor, made announcements of their peer learning sessions to students in class, reviewed course materials and gathered supplemental resources to review weekly session topics, organized/designed weekly peer learning sessions, regularly communicated with students by group chats, and assisted with pre-test reviews and other responsibilities assigned by the faculty (e.g., assist in the lab and/or help grade quizzes).

Usually juniors and seniors, the racial and ethnic demographics of the UTAs were similar to students enrolled in the mathematics gatekeeper courses. The similar race, ethnicity, and cultural attributes of UTAs with the students enrolled in the assigned courses were essential to the psychological closeness principles that foster proxy comparison. Psychological closeness refers to making a connection or identification to the proxy.

Given the UTAs successful prior course completion, they were in many cases familiar with the teaching methods and instructional approach of faculty and could thereby leverage their prior course knowledge and experience to support students. Twenty-four UTAs were assigned to gatekeeper mathematics courses across five consecutive semesters beginning Spring 2017 through Spring 2019. Though UTA implementation was not mandated for gatekeeper mathematics courses, faculty were encouraged to participate.

Methodology

A quasi-experimental design was employed to examine summative effects of the UTA intervention on student outcomes associated with perceptions about the quality and benefit of UTAs, students' mathematics confidence, student achievement, and student retention. A two-tailed *t*-test was used to estimate the difference in means between treatment and comparison groups based on non-random assignment. The *p* value determined the extent to which the null hypothesis could be rejected based on the threshold value of 0.05. Effect size measures followed the convention established by Cohen (1988). Students enrolled in gatekeeper mathematics courses with relatively consistent UTA interaction (i.e., before exams/tests, monthly, every two weeks or weekly) were assigned to the treatment group. Students in gatekeeper mathematics courses with none to inconsistent UTA interaction (i.e., hardly ever or not at all) were assigned to the comparison group. Descriptive statistics provided additional context. The study includes the spring 2017 pilot of Year 1 (2016-17 AY) and full implementation in Years 2 (2017-2018 AY) through 3 (2018-2019 AY). The abrupt onset of the COVID-19 pandemic prevented the project's last two years from being included in the study.

The following research questions guided this study:

1. Did the use of UTAs as comparison proxies in gatekeeper mathematics courses lead to positive student perceptions of the quality and benefit of mathematics UTAs?
2. Did the use of UTAs as comparison proxies improve students' mathematics confidence and student outcomes in gatekeeper mathematics courses?

Participants & Setting

The gatekeeper mathematics courses in this study include College Algebra, Pre-Calculus, Elementary Statistics, Calculus I, and Calculus II. All students enrolled in the five gatekeeper mathematics courses with assigned UTAs were invited to participate in the study. The research team visited classes participating in the study and informed students about the nature of the study as well as the expectations for participation. An opportunity was provided for students to ask questions. Students who wanted to participate voluntarily signed consent forms. To serve as an incentive for participation and survey completion, a nominal raffle incentive of $50 was awarded to a survey respondent randomly selected each semester.

Birthed out of necessity in resisting racism and segregation in the United States for the purpose of ensuring educational access to people of African descent in the diaspora, the HBCU setting is culturally relevant as it foregrounds equity, opportunity, and social justice in its institutional and educational mission (Toldson, 2018; Gasman & Nguyen, 2019; Sampson, 2023). We are intentional about using the term students of African descent to describe the demographics of study participants to be inclusive and more representative of the rich diversity and heritage inherent in blackness (e.g., Caribbean, Afro-Latinx, African, multi-racial, etc.), as recognized by Lincoln's first Black president, Horace Mann Bond (class of 1923) as he appropriately characterized students enrolled at the university as 'youth of African descent' (Bond, 1976, p. 3).

Data Sources

To address the research questions, we used quantitative data from student surveys administered at the end of each semester. The instrument was adapted from a pre-existing end-of-semester survey (α=0.932) widely used in higher education for Supplemental Instruction (Simmons et al. 2020). A total of 1,188 undergraduate students of African descent enrolled in gatekeeper mathematics courses completed the end-of-semester survey on the use of UTAs corresponding to the gatekeeper mathematics course of enrolment for that semester. In addition to survey items on demographics and frequency of interaction with the assigned UTA, the instrument also addressed five constructs: quality of UTA *(e.g., my UTA explained course concepts clearly)*, benefit of UTA *(e.g., my UTA helped me understand the course material)*, mathematics confidence *(e.g., I am more confident now doing well in my college mathematics than I was at the beginning of the course),* student achievement *(having a UTA helped me complete the course)*, and student retention *(having a UTA helped me improve my grade in the course).* Survey items to measure the five constructs were formatted with a 5-point Likert scale (5=strongly agree to 1=strongly disagree). Exposure to treatment relied on self-report survey data about the frequency of attending the weekly peer-learning sessions. De-identified course grades were used to identify trends in pass rates. Four of the gatekeeper mathematics courses included in this study consistently used UTAs: College Algebra, Elementary Statistics (beginning Spring 2017), Pre-Calculus, and Calculus 1. The fifth course, Calculus II, was a late UTA adopter (Spring 2018).

Results

As shown in Table 1, pass rates in the four gatekeeper mathematics courses with consistent use of UTAs increased to 61.0% from 55.3% at baseline. Compared to baseline, Calculus I had the greatest pass rate gain (+12.0 percentage points), followed respectively by Elementary Statistics (+9.6 percentage points) and Pre-Calculus (+8.0 percentage points). Pass rates in College Algebra increased slightly.

Mathematics Gatekeeper Courses	2015-16 AY – Fall 2015 Baseline	Spring 2017	Fall 2017	Spring 2018	Fall 2018	Spring 2019	UTA Use Avg. Pass Rates
College Algebra	43.1%	30.0%	45.6%	50.5%	41.6%	53.8%	44.1%
Elementary Statistics	72.0%	90.3%	75.7%	81.7%	89.4%	80.7%	83.6%
Pre-Calculus	51.2%	49.0%	69.2%	43.1%	97.1%	45.8%	59.2%

Calculus I	47.0%	72.3%	80.9%	73.1%	46.2%	34.7%	59.0%
Avg Pass Rate	55.3%	60.4%	67.9%	62.1%	68.6%	53.8%	61.0%

Table 1. Pass Rates in Gatekeeper Mathematics Courses with UTAs compared to Baseline, Spring 2017 through Spring 2019

Descriptive data reveal positive student results in several areas. Among students enrolled in gatekeeper mathematics courses with assigned UTAs, 82.6% of survey respondents were aware of who their assigned UTA was, 85.7% knew the role of their UTA, and 84.8% knew how, when, and where to get UTA assistance. Students also possessed positive perceptions about faculty support for the use of UTAs with 80% reporting that their mathematics faculty introduced their UTAs to them directly in class, and 70.1% reporting encouragement from mathematics faculty to attend UTA sessions. A large majority felt that students who attended UTA sessions wanted to learn as much as possible to do well in class, evidenced by 82.8% in agreement. However, another 37.9% felt that students who attended UTA sessions were most likely *not good* in mathematics. We regard this negative association emblematic of a false stigma or shame narrative of not being *good* or *smart* enough to succeed in mathematics derived from racialized experiences in mathematics that advance persistent inferiority and deficit narratives among Black learners in the classroom and in society (Davis, 2022; Roberts & Almeida, 2023). The false stigma narrative associated with UTA use decreased concomitantly with increased exposure and familiarity of UTAs in gatekeeper mathematics classes. Those students not attending UTA sessions also encountered barriers to access due to scheduling conflicts and other obligations (e.g., work, athletics). As shown in Table 2, the retention mean scores of those in the comparison group with little to no attendance to UTA-sessions were significantly lower than the treatment group suggesting a greater risk of not passing the course and potentially dropping out of STEM. This study did not have access to institutional student-level data to delve further into this issue.

The *t*-test results reveal evidence of positive significant effects of UTAs in mathematics gatekeeper courses for the treatment group. As shown in Table 2, students who received UTA assistance in mathematics gatekeeper courses demonstrated significant better results than the comparison group across all constructs, and with large effect size in most constructs. The treatment group also demonstrated significant better results in their mathematics confidence with medium effect size. We would expect the self-reported mathematics confidence construct as a result of UTA session attendance to be responsive to the proxy comparison framework.

	Treatment			Comparison						
Construct	N	Mean	SD	N	Mean	SD	*df*	*t*	*P*	Cohen's *d*
Quality	293	4.3	1.2	410	2.0	1.8	701	18.3	<.001	1.4052
Benefit	293	3.9	1.3	410	1.9	1.8	701	16.6	<.001	1.2682
Confidence	293	3.8	1.4	410	2.7	1.8	701	9.0	<.001	0.6870
Retention	293	3.8	1.4	410	1.9	1.7	701	16.0	<.001	1.2206
Achievement	293	3.9	1.4	410	1.8	1.8	701	16.9	<.001	1.2961

Table 2. Treatment and Comparison *T*-test Results for UTA Use in Mathematics Gatekeeper Courses

As shown in Tables 3-7, disaggregation by gatekeeper mathematics course also demonstrated significantly better results for the treatment group across all constructs in all courses with sizable effect size.

	Treatment			Comparison						
Construct	N	Mean	SD	N	Mean	SD	*df*	*t*	*P*	Cohen's *d*
Quality	102	4.0	1.5	184	1.9	1.7	284	10.5	<.001	1.3080
Benefit	102	3.7	1.6	184	1.7	1.7	284	9.3	<.001	1.1532
Confidence	102	3.7	1.5	184	2.7	1.8	284	4.7	<.001	0.5861
Retention	102	3.7	1.6	184	1.7	1.7	284	9.9	<.001	1.2273
Achievement	102	3.7	1.6	184	1.7	1.7	284	9.9	<.001	1.2273

Table 3. College Algebra UTA Use Treatment and Comparison *T*-test Results

	Treatment			Comparison						
Construct	N	Mean	SD	N	Mean	SD	*df*	*t*	*P*	Cohen's *d*
Quality	67	4.0	1.5	113	2.2	1.7	178	7.1	<.001	1.0740
Benefit	67	3.6	1.4	113	1.9	1.7	178	6.7	<.001	1.0406
Confidence	67	3.5	1.6	113	2.6	1.8	178	3.2	<.001	0.4978
Retention	67	3.5	1.6	113	2.0	1.8	178	5.6	.0015	0.8563
Achievement	67	3.5	1.6	113	2.0	1.8	178	6.6	<.001	1.0160

Table 4. Elementary Statistics UTA Use Treatment and Comparison *T*-test Results

	Treatment			Comparison						
Construct	N	Mean	SD	N	Mean	SD	*df*	*t*	*P*	Cohen's *d*
Quality	60	4.4	0.8	68	2.1	1.9	126	8.5	<.001	1.5182
Benefit	60	3.9	1.0	68	2.0	1.8	126	7.2	<.001	1.2728
Confidence	60	3.8	1.2	68	2.4	1.8	126	4.8	<.001	0.8543
Retention	60	3.9	1.2	68	1.8	1.8	126	7.6	<.001	1.3511
Achievement	60	4.0	1.2	68	1.9	1.8	126	7.6	<.001	1.3443

Table 5. Pre-Calculus UTA Use Treatment and Comparison *T*-test Results

	Treatment			Comparison						
Construct	N	Mean	SD	N	Mean	SD	*df*	*t*	*P*	Cohen's *d*

Quality	43	4.9	0.3	38	1.8	2.0	79	9.9	<.001	2.2063
Benefit	43	4.4	0.7	38	1.7	1.9	79	9.1	<.001	1.9956
Confidence	43	4.2	1.2	38	2.8	2.0	79	3.6	.0005	0.8042
Retention	43	4.2	1.2	38	1.7	1.8	79	7.8	<.001	1.7378
Achievement	43	4.4	1.0	38	1.6	1.7	79	8.8	<.001	1.9572

Table 6. Calculus I UTA Use Treatment and Comparison *T*-test Results

	Treatment			Comparison						
Construct	N	Mean	SD	N	Mean	SD	*df*	*t*	*P*	Cohen's *d*
Quality	21	4.9	0.2	7	3.6	1.7	26	2.6	.0160	1.1246
Benefit	21	4.6	0.6	7	3.7	1.9	26	2.0	.0587	0.8629
Confidence	21	4.6	0.7	7	3.1	1.8	26	3.2	.0033	1.4147
Retention	21	4.6	0.7	7	3.7	1.9	26	1.9	.0662	0.8370
Achievement	21	4.6	0.6	7	3.7	1.9	26	2.0	.0579	0.8660

Table 7. Calculus II UTA Use Treatment and Comparison *T*-test Results

Discussion

A growing body of research has described the benefits of UTAs in higher education (Lukie et al., 2019). While some studies focus on STEM, research is sparse on the use of UTAs in gatekeeper mathematics courses and particularly in the context of HBCUs. This study produced positive and significant results on the use of UTAs in gatekeeper mathematics courses at Lincoln University evidenced by positive student perceptions of UTA quality and benefit, increased mathematics confidence, achievement and retention. The HBCU setting is designed to afford a cultural context of positive racial socialization and absence of marginalization particularly for students of African descent and one in which STEM is particularly conducive to proxy comparative associations (Freeman et al., 2021). Students enrolled in gatekeeper mathematics courses could associate their own growth potential for content mastery to the academic achievement of their UTAs. In the HBCU setting, the use of UTAs in mathematics gatekeeper courses functioned as a key in unlocking the potential for increased mathematics confidence, retention and achievement among those students of African descent who participated in the intervention.

Students not directly engaged in the intervention did not have access to this specific key of UTAs as a proxy comparison for promoting positive student outcomes. While many students experienced conflicts in their schedules with UTA sessions and had other obligations (e.g., work), 37.9% of survey respondents reported that they felt UTAs were for students who are *not good* in mathematics. This stigmatic association with the intervention stems from the insidious racialized context of mathematics education that perpetuates false inferiority and deficit-oriented narratives encountered by Black students (Martin, 2019; Davis, 2022; Roberts & Almeida, 2023). Although most students also felt that UTA sessions were indeed for students interested in performing at their best, the stigmatic association was a barrier to participation. The project saw a decline in stigma perceptions associated with the intervention as students gained more familiarity and exposure to UTAs. However, students in the first-year of study new to the HBCU setting were more likely to perceive a stigmatic association with UTA use. Freeman and

colleagues (2021) found that first-year students at HBCUs majoring in STEM begin to experience an absence of marginalization as they experience counter-narratives by engaging with a STEM teaching and learning culture that supports positive social comparison incorporating similar racial, ethnic, and cultural attributes. The racialized narratives specific to mathematics may take longer to dispel and require more intensive efforts to provide access to appropriate comparison proxies early on in postsecondary education. Concerted efforts to incentivize students to attend UTA sessions and other proxy comparison mechanisms in addition to UTAs may be needed to reach more students along with further research in dismantling the stigmatic associations that frustrate efforts to unlock the gate to mathematics for more students of African descent.

Limitations

The study relied on self-report measures from survey data as the primary data source. While the internal reliability of the end-of-semester survey was sound, opportunities for the occurrence of social desirability responses were present, though none were evident in the exposure to treatment survey item. UTA session attendance records were uneven or not uniformly kept, and therefore could not be used as a reliable data source. The use of covariates as control variables could have strengthened the analysis and will be integrated in further study of the intervention.

Conclusion

This study on the use of UTAs in gatekeeper mathematics courses with similar racial and ethnic background of the students enrolled in the courses demonstrated significant results in increasing student outcomes inclusive of mathematics confidence, achievement and retention. The use of UTAs in gatekeeper mathematics courses unlocked positive mathematics outcomes for students of African descent. Refinement of the implementation to mitigate stigmatic associations with UTA session attendance will be needed to reach more students and is suggested for further study. The significant results accompanied by substantive effect sizes bode well for meaningful and practical application to other HBCUs and similar settings in higher education seeking to increase mathematics outcomes for students of African descent.

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