The influence of personality traits on academic motivation and learning strategies: A pathway to reducing STEM students attrition.

Adekemisola Olufunmilayo Asahiah, Morgan State University

Adekemisola Asahiah is a Doctoral student of Higher Education Administration, Department of Advanced Studies, Leadership and Development, Morgan State University. Her research interests include, research management; policy analysis; implementation and evaluation in Environmental studies and Engineering Education.

Oyinkansola Aladeokin, Morgan State University

Oyinkansola Aladeokin is a doctoral student and teaching fellow in the Department of Civil and Environmental Engineering at Morgan State University in Baltimore, Maryland. She holds a Bachelor of Technology (B.Tech) degree in Civil Engineering from Ladoke Akintola University of Technology and a Master of Science (M.Sc) in Sustainable and Resilient Infrastructure Engineering from Morgan State University. With over a decade of professional experience in infrastructure design and construction, she is passionate about advancing the development of safe, sustainable, and resilient civil infrastructure. Oyinkansola is also dedicated to mentoring and empowering the next generation of civil engineers. Her research spans a wide range of areas, including intelligent transportation systems, traffic safety, student development, and sustainable infrastructure.

Dr. Olushola V. Emiola-Owolabi, Morgan State University

Olushola Emiola-Owolabi is an engineering pedagogy specialist, researching active learning in engineering classrooms and specializing in qualitative methods research on teaching and learning – particularly in remote synchronous learning environments.

Dr. Oludare Adegbola Owolabi P.E., Morgan State University

Dr. Oludare Owolabi, a professional engineer in Maryland, joined the Morgan State University faculty in 2010. He is the director of the Sustainable Infrastructure Development, Smart Innovation and Resilient Engineering Research Lab, Department of Civil Engineering at Morgan State University.

Hannah Abedoh, Morgan State University

Hannah Abedoh is a highly motivated doctoral student in Business Management, specializing in Information Science and Systems. She is actively engaged in advanced research, focusing on the impact of Generative Artificial Intelligence on learning.

Oluwafisayo Jessica Adeolu, Morgan State University

Oluwafisayo Jessica Adeolu is a Master candidate in Data Analytics and Visualization at Morgan State University and a Research Assistant in the Department of Civil Engineering. Her research focuses on digital equity, higher education outcomes, and data-driven approaches to urban systems which includes traffic noise variability and academic success among underserved populations. With over a decade of professional experience in data analytics, customer experience leadership, and operational management across retail, manufacturing, and supply chain sectors in Nigeria, she brings a practitioner's perspective to her academic work.

Julius Ogaga Etuke, Morgan State University

Julius Ogaga Etuke is a seasoned civil engineer and Ph.D. Candidate in Civil Engineering at Morgan State University, where his research focuses on sustainable and resilient infrastructure engineering. With over 15 years of consulting and project leadership experience, primarily in Nigeria's infrastructure landscape, he brings a robust, practical perspective to academic inquiry. His doctoral research is at the cutting edge of transportation resilience, integrating virtual and augmented reality (VR/AR), climate adaptation modeling,

and data-driven solutions to improve disaster preparedness and risk mitigation in complex transportation systems. As a COREN-registered engineer and member of the Nigerian Society of Engineers, his work emphasizes impactful research and consultancy that bridges structural design principles with urgent sustainability and resilience challenges.

The influence of personality traits on academic motivation and learning strategies: A pathway to reducing STEM students' attrition (NSF IUSE Project).

1. Introduction

Graduates in science, technology, engineering, and mathematics (STEM) fields are essential for economic growth, technological advancement, and global competitiveness [1], [2]. Despite high workforce demand, many countries continue to experience shortages of qualified STEM professionals, particularly among marginalized populations in the United States [3], [4]. A major contributor to this shortage is persistent STEM attrition, defined as students leaving STEM programs by switching majors, withdrawing from college, or discontinuing their studies [5]. Attrition rates among African American students have been reported to be significantly higher than those of their white counterparts [6]. Although Historically Black Colleges and Universities (HBCUs) play a critical role in producing Black STEM graduates, attrition within these institutions remains a significant concern.

STEM attrition is widely recognized as a multifactorial issue influenced by academic preparedness, institutional resources, and socio-psychological factors [7], [8]. Among individual factors, personality traits have emerged as important predictors of students' learning behaviors, motivation, and academic outcomes [9], [10]. The Big Five personality model categorizes personality into openness, conscientiousness, extraversion, agreeableness, and neuroticism [11]. Prior studies have reported that traits such as openness and conscientiousness are positively associated with academic achievement, persistence, and emotional regulation in learning environments [12]–[14].

Motivation is another critical determinant of academic success and persistence in STEM disciplines. High levels of motivation have been identified as essential for success in demanding academic fields, while low motivation has been linked to poor academic performance and increased likelihood of dropout [15]–[18]. In addition, pedagogical approaches such as active learning have been shown to improve student engagement, enhance learning outcomes, and support persistence in STEM education [19]–[21].

Although personality traits, motivation, and pedagogical practices have each been widely studied, limited research has examined how these factors interact to influence motivational outcomes within HBCU STEM environments. Understanding these relationships is essential for developing evidence-based strategies to reduce attrition among underrepresented STEM students.

Accordingly, this study investigates the relationship between personality traits, active learning pedagogical interventions, and motivational ratings among STEM students at an HBCU. Specifically, the study aims to:

1. examine the relationship between personality traits and motivational ratings;
2. determine whether pedagogical interventions influence motivational ratings; and
3. assess whether personality traits influence motivation following pedagogical intervention.

2. Conceptual Framework

This study is grounded in the Big Five personality framework and motivation theory to examine factors influencing STEM students' academic motivation. The conceptual model was developed by the authors based on established theoretical constructs and prior empirical findings in educational psychology and STEM education research.

The Big Five model categorizes personality into five dimensions: openness, conscientiousness, extraversion, agreeableness, and neuroticism [11]. These traits influence how students perceive academic challenges, regulate emotions, and engage with learning environments [9], [10]. Prior research has shown that openness and conscientiousness are positively associated with academic persistence, self-regulation, and learning achievement, while neuroticism is often linked to academic stress and reduced performance [12]–[14].

Academic motivation serves as a central outcome variable within the framework. Motivation initiates learning behaviors, sustains academic effort, and supports goal-directed engagement in demanding disciplines such as STEM [17], [18]. Students with higher motivation levels are more likely to persist through academic challenges and demonstrate stronger learning outcomes [15], [16].

In addition to individual personality factors, pedagogical practices are conceptualized as contextual influences on student motivation. Active learning strategies that promote student participation, collaboration, and engagement have been shown to enhance motivation and improve learning outcomes in STEM education [19]–[21]. Within this study, pedagogical intervention is treated as an environmental factor that may influence motivational ratings directly and potentially interact with personality traits.

Based on this framework, the study examines whether personality traits predict students' motivational ratings, whether pedagogical interventions influence motivation, and whether interaction effects exist between these factors.

3. Methods

3.1 Research Design

This study employed a quantitative research design to examine the relationship between personality traits, pedagogical interventions, and academic motivation among STEM students. A structured survey instrument was used to collect self-reported data on personality traits, motivational ratings, and perceptions of pedagogical practices. The quantitative approach enabled systematic analysis of relationships among variables and supported objective evaluation of the study objectives.

3.2 Participants and Setting

Participants consisted of undergraduate and graduate students enrolled in STEM programs at a Historically Black College and University located in the northeastern United States. A total of 163 students participated in the study, representing disciplines including Civil and Environmental Engineering, Computer Science, and Biology. The sample included both full-time and part-time students across different academic levels, providing a diverse representation of STEM learners within the institution.

3.3 Data Collection Instrument

Data were collected using a questionnaire that incorporated measures of personality traits, motivational ratings, and perceptions of pedagogical interventions. Personality traits were assessed based on the Big Five personality dimensions. Motivational ratings were captured using self-reported Likert-scale responses that reflected students' academic engagement, persistence, and effort. Pedagogical intervention items measured students' exposure to active learning strategies, including collaborative learning and interactive instructional practices.

3.4 Data Analysis Procedures

Multiple statistical techniques were employed to analyze the relationships among variables and address the study objectives. Kendall's tau-b correlation analysis was used to examine associations between personality traits and motivational ratings. Linear regression analysis was conducted to evaluate the predictive influence of personality traits on motivation. Ordinal logistic regression was applied to assess the impact of pedagogical interventions on motivational ratings, while hierarchical linear regression analysis was used to examine the combined and interaction effects of personality traits and pedagogical interventions.

The use of multiple analytical methods strengthened the robustness of the study by allowing comprehensive evaluation of direct, indirect, and interaction relationships among variables. This multi-analytical approach enhanced internal validity and improved interpretability of findings related to student motivation within the STEM educational context.

4. Results

4.1 Participant Characteristics

A total of 163 STEM students participated in the study. Of these, 62.0% identified as male and 38.0% as female. Participants were distributed across age groups, with the largest proportions between 21–25 years and 26–30 years. Approximately 50.3% were graduate students, while the remaining participants were undergraduates across all academic levels. Students from Civil and Environmental Engineering constituted the largest proportion of the sample (65.6%), followed by Computer Science (26.4%) and Biology (8.0%). These distributions indicate broad representation of STEM learners within the institution.

4.2 Relationship Between Personality Traits and Motivation

Correlation analysis using Kendall's tau-b indicated a weak positive relationship between personality traits and motivational ratings ($r = 0.138$). However, the relationship was not statistically significant at the 5% level ($p = 0.071$). This suggests that although higher personality trait scores were slightly associated with increased motivation ratings, the relationship was not sufficiently strong to demonstrate a meaningful predictive effect.

Table 1. Correlation Between Personality Traits and Motivation

Variable	Kendall's T	p-value
Personality Traits vs. Motivational Rating	0.138	0.071

4.3 Predictive Effect of Personality Traits

Linear regression analysis further examined whether personality traits predicted motivational ratings. Results showed a small positive regression coefficient (B = 0.043; B = 0.047), indicating that increases in personality trait scores were associated with only minimal increases in motivational ratings. The relationship was not statistically significant (p = 0.554), confirming that personality traits alone did not significantly predict student motivation.

Table 2. Regression Analysis of Personality Traits Predicting Motivation

Predictor	B	ù	p-value
Personality Traits	0.043	0.047	0.554

4.4 Influence of Pedagogical Interventions

Ordinal logistic regression analysis showed that pedagogical intervention categories did not significantly predict motivational ratings. Compared to the reference category, intervention categories exhibited negative or negligible regression coefficients, none of which reached statistical significance. These results indicate that exposure to active learning strategies did not produce measurable differences in self-reported motivation among the participants.

4.5 Combined Effects of Personality Traits and Pedagogy

Hierarchical regression analysis examined the combined and interaction effects of personality traits and pedagogical interventions on motivational ratings. Results indicated that neither personality traits nor pedagogical interventions independently predicted motivation. Additionally, the interaction term between personality traits and pedagogical intervention was not statistically significant, suggesting no moderating effect between these variables.

Table 3. Summary of Hierarchical Regression Findings

Predictor	B	p-value
Personality Traits	0.117	0.152
Pedagogical Intervention	0.030	0.680
Interaction Effect	−0.131	0.454

Overall, the results consistently demonstrated weak and statistically non-significant relationships between personality traits, pedagogical interventions, and motivational ratings. The findings indicate that, within this sample, neither personality characteristics nor instructional interventions independently or jointly explained significant variations in students' motivation.

5. Discussion

This study examined the relationship between personality traits, pedagogical interventions, and motivational ratings among STEM students at an HBCU. The findings revealed weak and statistically non-significant relationships across all tested models, indicating that neither personality traits nor pedagogical interventions independently or jointly predicted motivational outcomes.

These results contrast with many prior studies that have reported strong associations between personality traits and academic performance in STEM disciplines [22]–[24]. However, the findings are consistent with literature suggesting that the influence of personality traits on learning outcomes is often context-dependent and may vary based on factors such as gender, field of study, and institutional environment [25]–[29]. In particular, the composition of the study sample likely contributed to the observed results. Approximately half of the participants were graduate students, who typically exhibit higher levels of intrinsic motivation and more defined academic goals. This high baseline motivation may have reduced variability in motivational ratings and limited the detectable effects of personality traits and pedagogical interventions.

Additionally, the findings support arguments that institutional and environmental factors may play a more significant role in influencing STEM persistence than individual personality differences alone. Previous research has highlighted the importance of institutional support, mentoring, and sense of belonging in reducing STEM attrition, particularly within minority-serving institutions [30]. In this context, the supportive academic environment of the HBCU may have mitigated the influence of individual personality characteristics on motivation.

The lack of significant effects for pedagogical interventions also contrasts with prior studies demonstrating positive impacts of active learning on engagement and learning outcomes [19]–[21]. One possible explanation is that pedagogical interventions may influence long-term persistence and academic performance rather than short-term self-reported motivational ratings. These findings suggest that motivation in STEM education is shaped by complex interactions between individual, institutional, and contextual factors rather than by single predictors alone.

6. Conclusion and Future Work

This study highlights the complex relationship between personality traits, pedagogical interventions, and academic motivation among STEM students in an HBCU context. Although prior research has widely linked personality traits and active learning strategies to improved academic outcomes, the findings of this study indicate that their influence on short-term motivational ratings may be less pronounced than previously assumed. The results suggest that institutional context, baseline motivation levels, and student characteristics such as academic level may play a more significant role in shaping motivation and persistence. Future research should therefore focus on stratified analyses separating undergraduate and graduate populations and incorporate institutional and environmental variables to better understand the factors influencing STEM retention among underrepresented students.

7. Conclusion and Future Work

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