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NEXUS OF STUDENTS' ACADEMIC HARDNESS AND SELF-EFFICACY IN PHYSICS: EXAMINING THE MODERATING ROLE OF GENDER

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Abstract

This study investigated academic hardiness as a predictor of secondary school students' self-efficacy in Physics in Awka Education Zone. Two research questions and two null hypotheses, tested at the 0.05 level of significance, guided the research. A correlational survey research design was adopted for the study. The population consisted of 6072 (2927 males and 3145 females) senior secondary school two (SSS 2) students in the 67 public secondary schools in Awka Education Zone, from which a sample of 212 (105 males and 107 females) SSS 2 students was drawn using a multistage sampling procedure. The adapted Academic Hardiness Scale (SAHS) and Physics Self-efficacy Scale (PSS) were the instruments used to collect data for the study. The instruments were validated by three experts from the Faculty of Education, Nnamdi Azikiwe University, Awka. The reliability of the instruments were established using the Cronbach Alpha technique, which yielded coefficients of .62 and .90 respectively. Data were collected through direct administration with the help of two research assistants. The collected data were analyzed using the Pearson Product-Moment Correlation, coefficient of determination (R^2), and ANOVA analysis. The findings of the study revealed that academic hardiness is not a significant predictor of male and female secondary school students' self-efficacy in Physics. Based on the findings, it was recommended that Physics teachers should systematically incorporate cooperative learning strategies, form study groups, and create a classroom culture where asking questions and seeking help is normalized and encouraged. Also, it was recommended that students should view difficult topics in Physics not as indicators of low ability but as opportunities to learn and grow, leveraging social support to persist through them.

Introduction

Understanding the nature, effects, and factors that predict students' self-efficacy is crucial for comprehending the various aspects of academic life related to it. This understanding is essential for improving education. Education is a veritable tool for facilitating the development of any nation (Birabil and Ogeh, 2020). Within the broad spectrum of education, science education is crucial for a nation's scientific and technological development. Thus, in recognizing the importance of science education to national development, and in line with global standards, the Nigerian government implemented the teaching and learning of science across all levels of education (Federal Republic of Nigeria (FRN, 2013), ranging from basic to tertiary education.

Sandwiched between the basic and tertiary levels of education is the secondary education. This level of education is received after the defunct primary education and before tertiary education. The secondary level of education is divided into two: upper basic education (formerly known as junior secondary) and senior secondary education. Just as in other levels, students are expected to receive instruction in science subjects at this level to achieve one of the objectives of secondary education, which is to provide trained manpower in the applied science, technology, and commerce at sub-professional grades (FRN, 2014). Receiving science instruction at the secondary education level is crucial because some students may not have the opportunity to further their studies beyond this level. This category of students joins the nation's subprofessional workforce to contribute their quota to the nation's development (Joshua, as cited in Nwune & Nwoye, 2021). One of the science subjects wherein students are exposed to science instruction at the secondary level of education is Physics.

Physics is a branch of science that uses physical laws and principles to explain events in the universe. Tezer and Asiksoy (2015) defined it as a discipline that employs experimental observations and quantitative measurements to enhance our understanding of natural events. Physics is characterized by its abstract concepts, which necessitate mathematical modelling to achieve their idealization. This distinctiveness has driven the evolution of Physics education from a mere exchange of theoretical knowledge between teachers and students to experimental activities that encourage students to engage actively in scientific inquiry and acquire knowledge independently (Cai, Liu, Wang, Liu, & Liang, 2021; Maison, Syahria, Syamsurizal, & Tanti, 2019). These researchers further posited that this distinctiveness leads students to perceive Physics as a challenging subject. Similarly, Kapucu (2016) posited that students often perceive Physics as a difficult and less favourable subject compared to other science subjects due to its heavy reliance on Mathematics. This heavy reliance can lead some students to perceive Physics as very problematic, as they feel they lack problem-solving skills (Chala, Kedir, & Wami, 2020).

These negative perceptions of students concerning Physics can affect their self-efficacy about the subject.

Self-efficacy generally refers to an individual's perceptions of their capacities to excel at any aspect of life despite obstacles. Within the context of the present study, it can be defined as students' perceptions of their capacities to excel in Physics. The concept of self-efficacy was first introduced by Bandura (1999) as one's capacity to achieve a given task by organizing and executing the required courses of action. This definition suggests that even in the presence of capacity, a low self-efficacy belief can translate to failure in completing a task or even attempting it. More recent literature buttresses the idea that the self-efficacy of individuals in achieving a task is innate (Ugwuanyi, Okeke, & Ageda, 2020) and dynamic (Nissen & Shemwell, 2016), implying that they vary across individuals, fields, and levels. Within an academic context, students' self-efficacy influences their level of engagement in learning tasks. This position was corroborated by Samsdin, Jamali, Zain, and Ale Ebrahim (2020), who posited that students are more likely to engage in learning tasks they feel efficacious about. Similarly, self-efficacy affects the level of effort students are willing to commit to learning a task (Gurcay & Ferah, 2018). These positions suggest that students' success at any given learning task is determined by their self-efficacy about the task, since task engagement and effort levels are products of students' self-efficacy.

Studies have been conducted to investigate students' self-efficacy about Physics and how it affects various learning outcomes in the subject. For example, Gurcay & Ferah (2018) observed from the findings of their study that students' Physics self-efficacy and self-regulation significantly predicted their critical thinking abilities in the subject, accounting for 55% of the variance in critical thinking scores. Another Physics learning outcome affected by students' self-efficacy is their perceived cost of engagement in a learning task (Kim, Yu, Koebka, Lee, and Hecker, 2022). The findings by the researchers suggest that the higher the students' self-efficacy, the higher their Physics learning engagement. Additionally, Kapucu (2016), Ugwuanyi *et al.* (2020), and Ede and Anosike (2023) reported that students' self-efficacy in learning Physics were a significant predictor of their academic achievement in the subject. However, the findings of

Achufusi and Utaka (2021) suggested otherwise. According to the researchers, self-efficacy does not predict students' academic achievement in Physics.

Considering the significance of students' self-efficacy in various Physics learning outcomes, studies have also been conducted to identify factors that enhance these. This research trend aligns with Bandura (1999), who suggested that self-efficacy can be improved among individuals. For instance, research has explored the significance of self-efficacy on several learning variables, such as environmental factors (Maison, Syahria, Syamsurizal, and Tanti, 2019), teaching and assessment approaches (Cai *et al*., 2021; Samsudın, Jamalı, Zaın, and Ebrahım, 2020), and student-related factors (Tan, Liang, and Tsai, 2021). Although student-related factors have been previously examined, however, limited research work has focuses on academic hardiness as intrinsic mechanisms that influence students' self-efficacy, providing a holistic approach to their enhancement. This approach aligns with Bandura's assertion that self-efficacy is enhanced through the individual intentionality.

Academic hardiness is a concept linked to perseverance in the face of academic challenges. The term was coined by Benishek and Lopez (2001) to explore why some students embrace academic challenges while others shy away from them due to fear of jeopardising their academic performance. The concept probes students' academic tenacity and intentionality in striving for academic excellence while coping with academic challenges (Kuo, Tsai, & Wang, 2021). According to Kuo et al. (2021), academic hardiness is understood as a combination of three attitudes (3Cs): commitment, control, and challenge. Commitment pertains to situations where individuals are willing to engage in certain activities or tasks. Control relates to one's desire to influence important events. Challenge, on the other hand, concerns the extent to which one perceives stressful situations as opportunities for learning rather than as threats.

The 3Cs of hardy attitudes empower individuals to overcome difficulties and view stressful circumstances as opportunities for learning. As students navigate the perceived learning challenges, particularly in Physics, and the stress linked to the subject, their self-efficacy tends to improve. Some research studies have indicated that academic hardiness predict students' self-efficacy. For example, Cheng, Tsai, and Liang (2019) suggested that to help graduate students overcome negative feelings and thoughts regarding their coursework and research tasks, they must develop the 3Cs of hardy attitudes. A similar finding among middle school students demonstrates that academic hardiness was significantly and positively correlated with learning self-efficacy (Wong, Liang, & Tsai, 2021). However, Zhou, Tang, Du, and Chen (2025) posited, based on their study's findings, that fostering academic hardiness in teenagers significantly enhances their academic stress and anxiety which has been noted to have negative impact on their self-efficacy. These contradictory research findings show that academic hardiness is critical to students' self-efficacy across all levels of education and thus demand further investigation.

It is worthy of note that several studies have investigated academic hardiness and self-efficacy among students in Physics and other subject areas. However, most of the recent studies on self-efficacy in Anambra State focused on students' general academic performance (Anierobi, Nwogbo, Ogbe, and Oyeyemi, 2022) and other science subjects like Mathematics. Thus, limited empirical work has considered students' self-efficacy in Physics in a limited resource educational settings like Anambra state. Moreover, most of the empirical studies reported contradictory findings in the self-efficacy scholarship. These research gaps necessitate the present study. Given that variability of students' self-efficacy may likely be influenced by their socio-demographic profiles, gender role in the nexus of academic hardness and self-efficacy was investigated.

Gender is the study of sex of participant which is mainly grouped into male and female. Gender disparity has long been a significant issue in academic discourse, particularly in STEM education. This issue spans enrolment, career choice, and self-efficacy (Musa & Musa, 2024). According to the researchers, these issues are mainly due to societal stereotyping that considers female students as incapable of doing science. Regarding self-efficacy, Kuo et al. (2021) observed that female students had lower self-efficacy in Engineering, Physics, and Mathematics. This finding may be attributed to the gender stereotyping faced by female students, as perpetrated by society. A similar finding was noted by Ugwuanyi *et al*. (2020). However, Kuo *et al*. observed that female students had higher self-efficacy in Chemistry compared to their male counterparts. This finding may be due to students' perception of Chemistry as a less mathematics-dependent subject, leading female students to perceive it as simpler to teach and learn. Considering these discrepancies in research findings, there is a need to determine whether gender acts as a significant moderator in the prediction of students' self-efficacy by academic hardiness.

Research Questions

The following research questions guided the study:

1. What is the predictive effect of academic hardiness on secondary school students' self-efficacy in Physics in Awka Education Zone?
2. What is the predictive effect of academic hardiness on male and female secondary school students' self-efficacy in Physics in Awka Education Zone?

Hypotheses

The following hypotheses were be tested at .05 level of significance:

1. The predictive effect of academic hardiness on secondary school students' self-efficacy in Physics in Awka Education Zone is not significant
2. The predictive effect of academic hardiness on male and female secondary school students' self-efficacy in Physics in Awka Education Zone is not significant

Methods

The research design is a correlational survey. The study was carried out in Awka Education Zone of Anambra State. The sample of the study comprised 212 (105 males and 107 females) SSS 2 students. The sample was selected through a multistage sampling procedure. Two instruments were used for collecting data in this study. They are the Students' Academic Hardiness Scale (SAHS) adapted from the Academic Hardiness Scale of Creed, Conlon, and Dhaliwal (2013), and Physics Self-efficacy Scale (PSS), adapted from the Physics Self-efficacy Scale of Tezer and Aşıksoy (2015). The authors found the Cronbach's alpha reliability coefficient values for the respective instrument as .77 and 0.98. After face validation and modifications by three experts in the department of science education and educational foundations, the internal consistencies were re-evaluated and coefficient values of .62 and .90 were obtained for SAHS and PSS respectively.

The data were collected by the researcher by administering the research instruments personally with the help of two research assistants. The research assistant were briefed onn the objectives of the study and how to collect data using the instruments. These assistants helped ensure that the sample for the research were used for completing the questionnaires. The research assistants assisted the researcher in the administration and collection of the instruments in each of the selected schools. The instruments were administered to the respondents and collected on the same day. The data collected were analysed using the Pearson Product-Moment Correlation (R) and the coefficient of determination (R^2) to answer the research questions while ANOVA was used to test the hypotheses at 0.05 level of significance.

Results

The predictive effect of academic hardiness on secondary school students' self-efficacy in Physics in Awka Education Zone

Table 1: Pearson Product-Moment Correlation and Coefficient of Determination of Academic Hardiness on Students' Self-efficacy in Physics

					Change Statistics				
Model	**R**	**R^2**	**Adjusted R^2**	**Std. Error of the Estimate**	**R Square Change**	**F Change**	**df1**	**df2**	**Sig. F Change**
1	.077[a]	.006	.001	13.08084	.006	1.243	1	210	.266

a. Predictors: (Constant), SAHS

Table 1 reveals the prediction of students' self-efficacy in Physics by their academic hardiness. The Pearson correlation coefficient (R = .077) indicates a low positive predictive relationship between academic hardiness and students' self-efficacy in Physics. The coefficient of determination (R^2 = .001) implies that academic hardiness predicts 0.1% of the change observed in students' self-efficacy in Physics in Awka Education Zone.

The predictive effect of academic hardiness on secondary school students' self-efficacy in Physics in Awka Education Zone is not significant.

Table 2: ANOVA Analysis of the Prediction of Academic Hardiness on Students' Self-efficacy in Physics

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	212.697	1	212.697	1.243	.266[b]
	Residual	35932.751	210	171.108		
	Total	36145.448	211			

a. Dependent Variable: PSS
b. Predictors: (Constant), SAHS

The result of the ANOVA analysis from Table 2 shows a non-statistically significant prediction of academic hardiness on students' self-efficacy in Physics, $F(1, 210) = 1.243$, $p > 0.05$. Since the p-value (.266) is greater than the 0.05 level of significance, the null hypothesis was not rejected. This decision indicates that academic hardiness is not a significant predictor of students' self-efficacy in Physics in Awka Education Zone.

The predictive effect of academic hardiness on male and female secondary school students' self-efficacy in Physics in Awka Education Zone?

Table 3: Pearson Product-Moment Correlation and Coefficient of Determination of Academic Hardiness on Male and Female Students' Self-efficacy in Physics

					Change Statistics				
Model	R	R^2	Adjusted R^2	Std. Error of the Estimate	R Square Change	F Change	df 1	df 2	Sig. F Change
Male	.129[a]	.017	.007	13.54975	.017	1.744	1	103	.190
Female	.016[a]	.000	-.009	12.69007	.000	.028	1	105	.868

a. Predictors: (Constant), SAHS

Table 3 reveals the prediction of male and female students' self-efficacy in Physics by their academic hardiness. The Pearson Correlation coefficient for male students (R = .129) indicates a low positive predictive relationship between academic hardiness and self-efficacy in Physics. The coefficient of determination ($R^2 = .017$) implies that academic hardiness predicts 1.7% of the change observed in male students' self-efficacy in Physics. For female students, the

Pearson Correlation coefficient (R = .016) indicates a low positive predictive relationship between academic hardiness and self-efficacy in Physics. The coefficient of determination (R^2 = .000) implies that academic hardiness does not predict any change observed in female students' self-efficacy in Physics in Awka Education Zone.

The predictive effect of academic hardiness on male and female secondary school students' self-efficacy in Physics in Awka Education Zone is not significant.

Table 4: ANOVA Analysis of the Prediction of Academic Hardiness on Male and Female Students' Self-efficacy in Physics

Gender	Model		Sum of Squares	df	Mean Square	F	Sig.
Male	1	Regression	320.151	1	320.151	1.744	.190^b
		Residual	18910.363	103	183.596		
		Total	19230.514	104			
Female	1	Regression	4.502	1	4.502	0.028	.868^b
		Residual	16908.974	105	161.038		
		Total	16913.477	106			

a. Dependent Variable: PSS
b. Predictors: (Constant), SAHS

Table 4 shows the result of the ANOVA analysis for the prediction of academic hardiness on male and female students' self-efficacy in Physics. The analysis showed a non-statistically significant prediction for both male students, $F(1, 103) = 1.744$, $p > 0.05$ and female students, $F(1, 105) = .028$, $p > 0.05$. Since the p-value for male (.190) and female (.868) are greater than the 0.05 level of significance, the null hypothesis was not rejected for both groups of students. This non-rejection indicates that academic hardiness is not a significant predictor of male and female students' self-efficacy in Physics in Awka Education Zone.

Discussion

Academic Hardiness as a Predictor of Physics Self-efficacy

The study's findings indicate that academic hardiness does not significantly predict students' self-efficacy in Physics within the Awka Education Zone. This finding diverges with the studies conducted by Cheng et al. (2019), Tan et al. (2021), and Zhou et al. (2025). The divergence may be ascribed to the domain-specific aspect of self-efficacy examined in this study. Students' self-efficacy in Physics is often developed by the effective resolution of numerical problems, comprehension of intricate Physics ideas, and receipt of affirmative feedback from teachers. Consequently, academic hardiness, as a mechanism for perseverance in the face of academic challenges, may equip students with the determination to confront challenging Physics concepts; yet, it does not inherently facilitate mastery experiences, resulting in the development of self-efficacy in the subject. Another probable reason for the present study's findings may be the systemic issues associated with the teaching and learning of Physics in the Awka Education Zone. The teaching of Physics in large classes with limited resources for experiments, coupled with an overloaded curriculum and teacher-centered methodologies, may have influenced the students' self-efficacy in the subject, regardless of their resilience. Consequently, the external systemic conditions under which the subject was taught may have undermined the students' internal motivation to excel, thereby impacting their self-efficacy in the subject.

Gender, Academic Hardiness and Physics Self-efficacy

The study's findings indicate a statistically non-significant predictive relationship between academic hardiness and self-efficacy in Physics among male and female students in the Awka Education Zone. Nonetheless, the academic hardiness of female students accounted for almost none of the variability in their self-efficacy in Physics. The insignificant predictive outcome for both group of students may be attributed to systemic problems, including large class sizes, insufficient resources, and ineffective pedagogical methods affecting the teaching and learning of Physics in the Awka Education Zone. Moreover, the non-predictive relationship noted specifically among female students may stem from sociocultural factors, including gender norms that undermine girls' capabilities in science subjects such as Physics, leading to a scarcity of prominent female role models in the field. Under these circumstances, a female student's academic hardiness may be undermined by adverse societal messages, disrupting the connection between hardiness and self-efficacy in Physics.

The study's findings align with Tan et al. (2021), and Zhou et al. (2025), who noted an insignificant difference in students' academic hardiness. Conversely, the results contradicted the findings of Cheng et al. (2019), who identified a notable gender disparity favouring male students in the prediction of self-efficacy based on students' academic hardiness.

Conclusion

The study concluded that enhancing Physics teaching and learning, as well as students' self-efficacy in the subject, should focus improving the social and instructional environment rather than solely promoting individual resilience. The study also concluded that interventions aimed at improving students' self-efficacy in Physics must be gender-responsive, actively establishing equitable support systems and counter-stereotypical messaging to ensure that the empowering effects of social support effectively reach and benefit female students.

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