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# MODERATING ROLES OF MOBILE PHONE ADDICTION AND SLEEP QUALITY IN THE PREDICTION OF CHEMISTRY ACHIEVEMENT BY ACADEMIC STRESS AMONG SECONDARY SCHOOL STUDENTS IN ENUGU STATE

**Nwobodo, Amauche Fortune [1] & Achufusi, Ngozi N.[2]**
[1, 2] - Department of Science Education
Nnamdi Azikiwe University, Awka
amauchenwobodo@gmail.com

## ABSTRACT

*The study investigated the moderating roles of mobile phone addiction and sleep quality on the predictive association between academic stress and secondary school students' Chemistry achievement in Enugu State, Nigeria. Three research questions guided the study and three null hypotheses were tested at 0.05 level of significance. The moderator predictive correlational research design was adopted. A total of 5,333 Senior Secondary Two (SS2) students offering Chemistry in public secondary schools in Enugu State constituted the population, out of which 600 students were sampled using multistage sampling procedures. The instruments for data collection were the Perception of Academic Stress Scale (PASS), Pittsburgh Sleep Quality Index (PSQI), and Smartphone Addiction Scale-Short Version (SAS-SV), validated by three experts. Reliability was established using Cronbach's Alpha (PASS = 0.82, PSQI = 0.79, SAS-SV = 0.81). Students' Chemistry scores were obtained from school records. Data were analysed using moderated multiple regression. Findings revealed that mobile phone addiction significantly moderated the predictive association between academic stress and Chemistry achievement, explaining an additional 1.0% of the variance. Sleep quality also significantly moderated the relationship, though with a smaller effect (0.2% additional variance). However, the joint moderation of mobile phone addiction and sleep quality was not significant. It was concluded that mobile phone addiction intensifies the negative effect of stress on Chemistry learning, while both moderators operate through independent pathways. The study recommended that schools implement phone-use guidelines and that teachers incorporate brief relaxation activities before Chemistry lessons.*

**Keywords:** Academic Stress, Mobile Phone Addiction, Sleep Quality, Moderation, Chemistry Achievement

## Introduction

Mobile phone addiction has emerged as a growing behavioural issue among students worldwide, characterized by excessive and compulsive use of phones, leading to negative consequences such as reduced focus on academic tasks, poor time management, and psychological issues like stress, anxiety, and depression (Li, Lepp & Barkley, 2021). Mobile phone addiction according to Samaha and Hawi (2020) is a behavioural dependency characterized by excessive use of mobile phones, leading to impaired daily functioning, social relationships, and academic performance. Studies by Sung, Lee, and Kim (2022) revealed that mobile phone addiction is increasingly linked to poor academic

performance, particularly in subjects like Chemistry, which require sustained focus and concentration. A global study by Lepp, Barkley, and Karpinski (2020) revealed that students with higher mobile phone addiction reported lower academic achievement, as excessive phone use diminishes study time and reduces attention to academic tasks and quality sleep.

Sleep quality is defined as one's satisfaction of the sleep experience, integrating aspects of sleep initiation, sleep maintenance, sleep quantity, and refreshment upon awakening (Rivera, Sim, Erickson & Cornell, 2024). Poor sleep quality has been shown to impair memory consolidation, attention, and problem-solving abilities, which are all essential for academic success, particularly in complex subjects like Chemistry. Globally, research has demonstrated a strong link between poor sleep quality and lower academic achievement. A study by Hagger, Keech, and Hamilton (2020) in Australia found that sleep deprivation negatively impacted students' academic performance, with significant effects in subjects requiring critical thinking and conceptual understanding, like Chemistry. In Nigeria and other developing countries, studies have also linked sleep quality to academic achievement, particularly in STEM subjects (Adom, 2021).

In Enugu State, Nigeria, where access to mobile technology is growing rapidly, secondary school students appear increasingly vulnerable to these behavioural and cognitive challenges. Mobile phone addiction and sleep quality can function as moderators in the predictive relationship between academic stress and academic achievement. The moderating role of mobile phone addiction could stem from its potential to increase academic stress levels while simultaneously reducing the time available for academic tasks. Similarly, sleep quality can act as a moderator because poor sleep impairs cognitive functioning, leading to lower academic achievement. Understanding how mobile phone addiction and sleep quality moderate the predictive relationship between academic stress and achievement in subjects like Chemistry is crucial for developing interventions.

## Statement of the Problem

Research has shown that mobile phone addiction is widespread among secondary school students, often leading to disrupted sleep patterns, reduced focus, and diminished cognitive functions, all of which can negatively influence academic performance. Despite the known associations between stress, technology use, and sleep quality, limited empirical evidence exists on how these factors interact to impact Chemistry achievement. Specifically, there is a gap in understanding how mobile phone addiction and poor sleep quality moderate the relationship between academic stress and students' academic achievement in Chemistry. This study seeks to address this gap by investigating the moderating roles of mobile phone addiction and sleep quality in the relationship between academic stress and academic achievement in Chemistry among secondary school students in Enugu State.

## Purpose of the Study

The purpose of the study was to investigate the moderating effects of mobile phone addiction and sleep quality on the

predictive association between academic stress and secondary school students' academic achievement in Chemistry in Enugu State. Specifically, the study investigated the:

1. Moderating effect of mobile phone addiction on the predictive association between academic stress and students' academic achievement scores in Chemistry.
2. Moderating effect of sleep quality on the predictive association between academic stress and students' academic achievement scores in Chemistry.
3. Moderating effect of mobile phone addiction and sleep quality jointly on the predictive association between academic stress and students' academic achievement scores in Chemistry.

**Research Questions**

The following research questions guided the study:

1. What is the moderating effect of mobile phone addiction on the predictive association between academic stress and students' academic achievement scores in Chemistry?
2. What is the moderating effect of sleep quality on the predictive association between academic stress and students' academic achievement scores in Chemistry?
3. What is the moderating effect of mobile phone addiction and sleep quality jointly on the predictive association between academic stress and students' academic achievement scores in Chemistry?

**Hypotheses**

The following null hypotheses were tested at 0.05 level of significance:

1. There is no significant moderating effect of mobile phone addiction on the predictive association between academic stress and students' academic achievement scores in Chemistry.
2. There is no significant moderating effect of sleep quality on the predictive association between academic stress and students' academic achievement scores in Chemistry.
3. There is no significant moderating effect of mobile phone addiction and sleep quality jointly on the predictive association between academic stress and students' academic achievement scores in Chemistry.

**Research Method**

The study employed the moderator predictive-correlational research design. This design is used to examine how the predictive association between two variables is influenced by a third variable, known as the moderator (Hayes, 2017). The study was conducted in Enugu State, Nigeria. The population comprised 5,333 Senior Secondary Two (SS2) students offering Chemistry in public secondary schools in Enugu State. The sample consisted of 600 SS2 students selected using multistage sampling procedures.

The instruments for data collection were: Perception of Academic Stress Scale (PASS) adapted from Bedewy and Gabriel (2015), Pittsburgh Sleep Quality Index (PSQI) adapted from Buysse, Reynolds, Monk, Berman, and Kupfer (1989), and Smartphone Addiction Scale-Short Version (SAS-SV) adapted from Kwon, Kim, Cho, and Yang (2013). The PASS consists of 18 items rated on a 5-point Likert scale. The PSQI assesses sleep quality over a one-month period with a global score ranging

from 0 to 21. The SAS-SV consists of 10 items rated on a 6-point scale. Students' Chemistry scores for the most recent academic year were collected using a proforma.

The instruments were validated by one lecturer in the Department of Science Education and one from the Department of Educational Foundations (Measurement and Evaluation Unit) at Nnamdi Azikiwe University, Awka. Reliability was established using Cronbach's Alpha, yielding coefficients of .82 for PASS, .79 for PSQI, and .81 for SAS-SV. The instruments were distributed by 6 research assistants. Data were analyzed using moderated multiple regression (MMR). All null hypotheses were tested at 0.05 significance level.

**Presentation of Results**

**Research Question 1:** What are the mediating effects of mobile phone addiction on the predictive association between academic stress and students' academic achievement scores in Chemistry?

**Table 1:** Moderating Effect of Mobile Phone addiction on the predictive association between academic stress and students' achievement scores in Chemistry

| Model | R | $R^2$ | Adjusted R Square | $R^2$ Change | Std. Error |
|---|---|---|---|---|---|
| AS, MPA | .112[a] | .013 | .009 | .013 | 13.788 |
| AS, MPA, Ach., AS x MPA | .148[b] | .023 | .017 | .010 | 13.733 |

a. Predictors: (Constant), Mobile Phone Addiction (MPA), Academic stress (AS)
b. Predictors: (Constant), Mobile Phone Addiction, Academic stress, ASXMPA

Table 1 shows the moderation analysis which examined the influence of academic stress and mobile phone addiction on achievement in chemistry. It also examined whether mobile phone addiction moderates the relationship between academic stress and achievement in chemistry. The first regression model, which included the predictor variable academic stress and the moderator variable mobile phone addiction (MPA), explained 1.3% of the variance in students' achievement in chemistry, $R^2$ = .013. The second model which added the interaction term academic stress x mobile phone addiction (AS x MPA) explained additional 1.0% of the variance in students' achievement in Chemistry, $\Delta R^2$ = .010, bringing the total variance explained to 2.3%, $R^2$ = .023. The result suggest that mobile phone addiction moderates the predictive association between academic stress and students' achievement scores in Chemistry.

**Research Question 2:** What are the mediating effects of sleep quality on the predictive association between academic stress and students' academic achievement scores in Chemistry?

**Table 2:** Moderating Effect of Sleep Quality on the predictive association between academic stress and students' achievement scores in Chemistry

| Model | R | $R^2$ | Adjusted R Square | $R^2$ Change | Std. Error |
|---|---|---|---|---|---|
| AS, MPA | .108[a] | .012 | .008 | .012 | 13.794 |
| AS, MPA, Ach., AS x SQ | .116[b] | .014 | .008 | .002 | 13.794 |

a. Predictors: (Constant), Sleep quality (SQ), Academic stress (AS)
b. Predictors: (Constant), Sleep quality, Academic stress, ASXSQ

Table 2 shows the moderation analysis which examined the influence of academic stress and sleep quality on achievement in chemistry. It also examined whether sleep quality moderates the relationship between academic stress and achievement in chemistry. The first regression model, which included the predictor variable academic stress and the moderator variable sleep quality (SQ), explained 1.2% of the variance in students' achievement in chemistry, $R^2$ = .012. The second model which added the interaction term academic stress x sleep quality (AS x SQ) explained additional 0.2% of the variance in students' achievement in Chemistry, $\Delta R^2$ = .002, bringing the total variance explained to 1.4%, $R^2$ = .014. The result suggests that sleep quality moderates the predictive association between academic stress and students' achievement scores in Chemistry.

**Research Question 3:** What are the mediating effects mobile phone addition and sleep quality on the predictive association between academic stress and students' academic achievement scores in Chemistry?

**Table 3:** Moderating Effect of Mobile phone addiction and Sleep Quality on the predictive association between academic stress and students' achievement scores in Chemistry

| Model | R | $R^2$ | Adjusted R Square | $R^2$ Change | Std. Error |
|---|---|---|---|---|---|
| AS, MPA, SQ | .116[a] | .014 | .009 | .014 | 13.793 |
| AS, MPA, SQ, Ach., ASXMPAXSQ | .118[b] | .014 | .007 | .000 | 13.802 |

b. Predictors: (Constant), Mobile Phone Addiction, Academic stress, Sleep quality
c. Predictors: (Constant), Mobile Phone Addiction, Academic stress, Sleep quality, ASXMPAXSQ

Table 3 shows the moderation analysis which examined the influence of academic stress, mobile phone addiction and sleep quality on achievement in chemistry. It also examined whether mobile phone addiction and sleep quality, jointly, moderates the relationship between academic stress and achievement in chemistry. The first regression model, which included the predictor variable academic stress and the moderator variables mobile phone addiction (MPA) and sleep quality (SQ), explained 1.4% of the variance in students' achievement in chemistry, $R^2$ = .014. The second model which added the interaction term academic stress x mobile phone addiction x sleep quality (AS x MPA x SQ) explained no additional variance in students' achievement in Chemistry, $\Delta R^2$ = .000, the total variance explained remaining

1.4%, $R^2$ = .014. The result suggest that mobile phone addiction and sleep quality together did not moderates the predictive association between academic stress and students' achievement scores in Chemistry.

**Hypothesis 1:** There is no significant mediating effect of mobile phone addition on the predictive association between academic stress and students' academic achievement scores in Chemistry.

**Table 4:** Significance of Moderating Effect of Mobile Phone addiction on the predictive association between academic stress and students' achievement scores in Chemistry

| Model | | Sum of Squares | Df | Mean Square | F | Pvalue |
|---|---|---|---|---|---|---|
| 1 | Regression | 2533.656 | 3 | 844.552 | 4.478 | .004[c] |
| | Residual | 112402.969 | 596 | 188.596 | | |
| | Total | 114936.625 | 599 | | | |

a. Dependent Variable: Achievement
c. Predictors: (Constant), Mobile phone addiction, Academic stress, ASXSPA

Table 4 shows that there is a significant moderation effect of Mobile phone addiction on the predictive association between academic stress and academic achievement in Chemistry, F (3, 596) = 4.478, p < .05. The regression weight or prediction value of the interaction term is shown in Table 5.

**Table 5:** Prediction Value of the Interaction Term

| Model | Prediction Value |
|---|---|
| (Constant) | 120.883 |
| Academic stress | -.801 |
| Mobile phone addiction | -23.668 |
| ASXSPA | .360 |

The regression model ($Y= a + bX_1$) for the prediction of the mediating effect as derived from Table 5 therefore is:
Achievement = 120.883 - .801 (AS) – 23.668(MPA) + .360(AS x MPA)
Where, Achievement = Achievement score in Chemistry, MPA= Mobile Phone addiction, AS x MPA = interaction term between academic stress and mobile phone addiction.

**Hypothesis 2:** There is no significant mediating effect of sleep quality on the predictive association between academic stress and students' academic achievement scores in Chemistry.

**Table 6:** Significance of Moderating Effect of Sleep Quality addiction on the predictive association between academic stress and students' achievement scores in Chemistry

| Model | | Sum of Squares | Df | Mean Square | F | Pvalue |
|---|---|---|---|---|---|---|
| 1 | Regression | 1536.372 | 3 | 512.124 | 2.692 | .045[c] |
| | Residual | 113400.253 | 596 | 190.269 | | |
| | Total | 114936.625 | 599 | | | |

a. Dependent Variable: Achievement
c. Predictors: (Constant), Sleep Quality, Academic stress, ASXSQ

Table 6 shows that there is a significant moderation effect of sleep quality on the predictive association between academic stress and academic achievement in Chemistry, F (3, 596) = 2.692, p < .05. The prediction value of the interaction term is shown in Table 7.

**Table 7:** Prediction Value of the Interaction Term

| Model | Prediction Value |
|---|---|
| (Constant) | 65.638 |
| Academic stress | .030 |
| Sleep Quality | 7.984 |
| ASXSQ | -.115 |

The regression model ($Y= a + bX_1$) for the prediction of the mediating effect as derived from Table 7 therefore is: Achievement = 65.638 + .030(AS) + 7.984(SQ) - .115 (AS x SQ)
Where, Achievement = Achievement score in Chemistry, SQ= Sleep Quality, AS x SQ = interaction term between academic stress and sleep quality

**Hypothesis 3:** There is no significant mediating effect of mobile phone addition and sleep quality on the predictive association between academic stress and students' academic achievement scores in Chemistry?

**Table 8:** Significance of Moderating Effect of Mobile Phone addiction on the and Sleep Quality on the predictive association between academic stress and students' achievement scores in Chemistry

| Model | | Sum of Squares | Df | Mean Square | F | Pvalue |
|---|---|---|---|---|---|---|
| 1 | Regression | 1595.986 | 4 | 398.997 | 2.095 | .080[c] |
| | Residual | 113340.639 | 595 | 190.488 | | |
| | Total | 114936.625 | 599 | | | |

a. Dependent Variable: Achievement
c. Predictors: (Constant), Mobile phone addiction, Academic stress, Sleep quality, ASXMPAXSQ

Table 8 shows that there is a significant moderation effect of mobile phone addiction and sleep quality on the predictive association between academic stress and academic achievement in Chemistry, F (4, 595) = 2.09578, p > .05. The null hypothesis was not rejected meaning that there is no significant mediating effect of mobile phone addition and sleep quality on the predictive association between academic stress and students' academic achievement scores in Chemistry.

**Discussion of Findings**

The finding that mobile phone addiction significantly moderates the relationship between academic stress and Chemistry achievement suggests that the negative impact of academic stress on performance depends substantially on students' level of phone dependency. Students who are highly addicted to their mobile phones likely experience academic stress as more detrimental because their phones provide a readily available escape from studying difficult Chemistry concepts, leading to procrastination and reduced

practice time. The constant notifications fragment attention such that even when students intend to study, they cannot sustain the deep concentration required for mastering chemical problem-solving. This finding aligns with Alhassan, Samuel, and Agyemang (2019), who found that mobile phone addiction significantly mediated the relationship between academic stress and academic performance among university students in Ghana. Kang, Lee, and Lee (2019) similarly reported that mobile phone addiction served as a mediator that worsened the impact of academic stress on academic performance among South Korean college students.

The finding that sleep quality significantly moderates the relationship between academic stress and Chemistry achievement, though with a smaller interaction effect, reveals that poor sleep makes students more vulnerable to the academic consequences of stress. Chemistry requires the consolidation of procedural knowledge, which depends heavily on sleep-mediated memory processes. The smaller magnitude of the sleep quality interaction compared to mobile phone addiction suggests that in the Enugu State context, behavioural factors like phone use may have more immediate effects on the stress-achievement relationship. This finding aligns with Arslan and Akin (2018), who found that sleep quality mediated the relationship between academic stress and academic achievement among Turkish university students. Wilson, Caldwell, and Thacher (2020) also reported that sleep quality significantly moderated the relationship between perceived stress and academic performance among high school students in Ontario, Canada.

The finding that mobile phone addiction and sleep quality together do not significantly moderate the relationship suggests that these two moderators operate through separate pathways that do not synergistically combine. Mobile phone addiction may affect the stress-achievement relationship primarily through behavioural mechanisms such as time displacement and distraction, whereas sleep quality may operate through physiological mechanisms related to memory consolidation and cognitive restoration. The non-significant three-way interaction may also reflect that the academic stress experienced by SS2 Chemistry students in Enugu State may not reach the chronic levels necessary for the triple interaction to manifest.

## Conclusion

It can be concluded that mobile phone addiction intensifies the negative effect of academic stress on Chemistry learning, highlighting the need for phone-use interventions. Poor sleep quality also worsens the effect of academic stress on achievement, though to a lesser extent. The absence of a joint moderating effect implies that mobile phone addiction and sleep quality operate through independent pathways. Therefore, separate interventions targeting phone addiction and sleep quality may effectively buffer stress-related declines in Chemistry achievement.

## Recommendations

Based on the findings, the following recommendations are made:

1. Parents and school administrators should establish clear guidelines limiting

mobile phone use during study hours to reduce stress-amplifying distractions in Chemistry learning.

2. Guidance counsellors should design workshops on healthy phone-use habits specifically tailored for Chemistry students experiencing academic pressure.

3. School boards should adjust examination schedules and assignment deadlines to allow adequate sleep time for students preparing for Chemistry assessments.

4. Teachers should incorporate brief relaxation or mindfulness activities at the start of Chemistry lessons to help students regulate stress before engaging with complex content.

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