



EVALUATION OF GENDER AND SCHOOL LOCATION DIFFERENCES IN STUDENTS' PSYCHOMOTOR SKILLS IN PHYSICS AS MEASURED BY PSYCHOMOTOR SKILLS ASSESSMENT IN PHYSICS

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Abstract

This study investigated gender and school location differences in students' psychomotor skills in Physics as measured by the Psychomotor Skills Assessment in Physics (PSAP). The objective of this study is to examine gender and school location differences in students' psychomotor skills in Physics as measured by the Psychomotor Skills Assessment in Physics (PSAP). The study adopted instrumental research design. The study was part of a larger instrumentation study conducted in South-East Nigeria. A sample of 384 Senior Secondary School III Physics students was selected through multistage sampling from 12 secondary schools. Data were generated using PSAP, a 50-item observational rating scale with five subscales: Basic Fundamental Movement, Perceptual Ability, Physical Ability, Skilled Movement, and Non-Discursive Communication. Mean and standard deviation were used to answer the research questions, while independent-samples t-test was used to test the hypotheses at the 0.05 level of significance. The results showed that male students obtained a higher overall mean score ($M = 214.66$, $SD = 6.55$) than female students ($M = 211.71$, $SD = 5.60$), and the difference was statistically significant, $t(382) = 4.68$, $p < .001$. Urban students also recorded a higher overall mean score ($M = 215.15$, $SD = 6.46$) than rural students ($M = 211.96$, $SD = 5.77$), and the difference was statistically significant, $t(382) = 5.08$, $p < .001$. Descriptively, the largest differences appeared in the Skilled Movement subscale, in favour of male and urban students. The study concludes that gender and school location are associated with differences in students' psychomotor performance in Physics. It recommends more equitable access to laboratory practice, targeted support for underperforming groups, and stronger practical engagement in rural schools.

Keywords: psychomotor skills, Physics practical, gender differences, school location, PSAP, secondary school students

Introduction

Practical work remains a central component of science education because it enables

students to move beyond verbal or theoretical descriptions and engage directly with scientific phenomena, tools, and procedures.



Hofstein and Lunetta (2022) argued that the laboratory occupies a central and distinctive role in science education because it supports inquiry, knowledge construction, and the development of scientific skills. In Physics, this role is especially important because many concepts become meaningful only when learners manipulate apparatus, observe relationships, take measurements, and interpret results in concrete settings. Effective Physics teaching, therefore, is not limited to cognitive achievement alone; it also requires the development and assessment of students' practical and psychomotor competencies.

Psychomotor skills refer to observable performance abilities demonstrated through coordinated physical action in task execution. In science education, Adesoji, & Ibraheem, (2022) explained that the psychomotor domain includes process skills such as observing, manipulating equipment and materials, measuring, experimenting, communicating, inferring, interpreting data, and formulating hypotheses. They further noted that these practical skills are often under-assessed because teachers frequently rely on written laboratory reports rather than direct observation of what students actually do during practical work. This distinction is important because a student may produce a correct written answer without demonstrating competent experimental performance, just as a student may perform a procedure reasonably well but produce weak written outcomes. For this reason, direct performance-based measures such as the Psychomotor Skills Assessment in Physics (PSAP) are highly relevant for evaluating students' actual psychomotor competence in Physics.

One factor that may influence students' psychomotor performance in Physics is gender. Studies in physics laboratory settings

suggest that gender differences do not always appear merely in overall participation, but often in the types of tasks students perform during practical work. Day et al. (2016), for example, found that in mixed-gender first-year physics laboratory pairs, male students tended to dominate computer use, while female students spent more time writing or speaking with peers. Fernandez et al. (2023) similarly reported that female students spent more time recording and taking notes and less time using equipment during practical laboratory-based activities. Building on these and related studies, Doucette and Singh (2024) concluded that gender-based differences in opportunities to interact with equipment, motivational outcomes, and learning experiences remain evident across many laboratory contexts. These findings suggest that gender may shape students' practical experiences in ways that are directly relevant to psychomotor skill development.

At the same time, the literature does not support a simplistic conclusion that one gender is universally better than the other in Physics practical work. Rather, the evidence suggests that gender differences are often context-dependent and influenced by task structure, access to apparatus, and the social organization of laboratory activities. Doucette and Singh (2024) emphasized that the issue is not merely whether male and female students are present in the laboratory, but whether they are equally positioned to engage in meaningful hands-on manipulation and technical action. This makes gender a significant variable for investigation in studies of psychomotor performance, especially in school contexts where students' opportunities to handle equipment may differ systematically.

Another variable that may influence psychomotor performance in Physics is school location. The broader education



literature indicates that rural–urban differences are often associated with inequalities in resources, expectations, and learning opportunities. Echazarra and Radinger (2019) reported that rural–urban gaps in educational outcomes often narrow when socio-economic status is considered, but rural students still tend to face reduced expectations and contextual disadvantages. In Physics education, however, findings on school location remain mixed. Abamba (2021), in a study of senior secondary Physics in Delta State, Nigeria, found that school location did not significantly affect students’ achievement when the 5E learning cycle was used. In contrast, Adebisi and Ayoola (2024) found that rural students in Osun State reported substantially lower exposure to practical teaching resources than urban students. They further observed that rural schools were less likely to teach with practical resources such as micrometer screw gauges, spring balances, measuring cylinders, and calorimeters. These contrasting findings indicate that school location may influence practical learning conditions, even where its direct effect on achievement is not always statistically significant.

The inconsistency in previous findings creates an important gap in the literature. Much of the existing research has focused on cognitive achievement, attitude, participation, or the availability of resources, while relatively fewer studies have directly examined students’ psychomotor skills in Physics using structured performance-based instruments. Yet, as Adesoji, and Ibraheem, (2022) argued, the actual “doing” of science cannot be adequately captured through written products alone. Since Physics practical work requires learners to manipulate apparatus, make measurements, assemble materials, and carry out procedures accurately, it is necessary to investigate

whether students differ in these skills by gender and by school location. This need provides the rationale for the present study, which examines gender and school location differences in students’ psychomotor skills in Physics as measured by the Psychomotor Skills Assessment in Physics (PSAP).

Statement of the Problem

Physics practical activities are expected to help students develop psychomotor skills such as observation, manipulation of apparatus, measurement, recording, and experimentation. However, evidence from secondary schools shows that many students still demonstrate poor practical performance and inadequate laboratory skills in Physics. This poor development of psychomotor skills may be associated with factors such as gender and school location. Students in urban schools may have better access to laboratory facilities, equipment, and qualified teachers than those in rural schools, while differences may also exist between male and female students in the acquisition of practical skills. Despite the importance of psychomotor skills in Physics learning, little attention has been given to evaluating these differences using standardized psychomotor skills assessment in Physics. Therefore, this study seeks to evaluate gender and school location differences in students’ psychomotor skills in Physics as measured by Psychomotor Skills Assessment in Physics.

Purpose of the Study

The purpose of this study was to examine gender and school location differences in students’ psychomotor skills in Physics as measured by the Psychomotor Skills Assessment in Physics (PSAP). Specifically, the study sought to:

1. determine the gender differences in students’ psychomotor performance in Physics as measured by PSAP and its subscales; and



2. determine the school location differences in students' psychomotor performance in Physics as measured by PSAP and its subscales.

Research Questions

The following research questions guided the study:

1. What differences exist between male and female students' psychomotor performance in Physics as measured by PSAP and its subscales?
2. What differences exist between students from urban and rural schools in psychomotor performance in Physics as measured by PSAP and its subscales?

Hypotheses

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

H₀₁: There is no significant difference in the mean overall psychomotor performance scores of male and female students in Physics as measured by PSAP.

H₀₂: There is no significant difference in the mean overall psychomotor performance scores of students from urban and rural schools in Physics as measured by PSAP.

Methodology

The study was part of a larger instrumentation study that developed and validated the Psychomotor Skills Assessment in Physics (PSAP). For the present paper, a comparative approach was used to examine differences in students' PSAP performance by gender and school location. The study was carried out in the South-East geopolitical zone of Nigeria. Three states—Abia, Enugu, and Imo—were selected from the zone for the study. The population of the study comprised all Senior Secondary School III (SS III) Physics students in the selected states. A sample of 384 students was selected through multistage sampling. First, three states were

selected from the five states in the South-East zone. Second, two local government areas were selected from each state, giving six local government areas. Third, two secondary schools were selected from each local government area, yielding 12 schools. Finally, 32 SS III Physics students were purposively selected from each school. The final sample comprised 207 male students and 177 female students, as well as 202 urban students and 182 rural students. Data were collected using the Psychomotor Skills Assessment in Physics (PSAP), a researcher-developed observational rating scale used alongside a structured practical activity. The PSAP consists of 50 items arranged into five subscales of 10 items each: Basic Fundamental Movement; Perceptual Ability; Physical Ability, Skilled Movement and Non-Discursive Communication

Each item was rated on a five-point scale. The instrument was designed to assess students' observable psychomotor performance during Physics practical tasks. The PSAP was face-validated by experts in Physics Education and Measurement and Evaluation. Construct validity was established through factor analysis, which retained 50 items after the elimination of 34 poorly performing items from the initial pool. In the broader validation study, the PSAP demonstrated acceptable psychometric properties. Cronbach's alpha for the overall instrument was .80, indicating good internal consistency. Inter-rater reliability using the Intraclass Correlation Coefficient (ICC) was .88, while the test-retest stability coefficient for the overall instrument was .86. These indices supported the use of the PSAP for assessing students' psychomotor skills in Physics. The instrument was administered to students in their respective schools during practical sessions. With the assistance of trained research assistants and Physics teachers, each student was observed while



performing the practical activity and rated using the PSAP. Mean and standard deviation were used to answer the research questions, while independent-samples *t*-test was used to test the two null hypotheses at the 0.05 level of significance.

Results

Research Question 1

What differences exist between male and female students' psychomotor performance in Physics as measured by PSAP and its subscales?

Table 1: Gender differences in students' psychomotor performance in Physics as measured by PSAP and its subscales

Subscale	Gender	N	Mean	SD	Mean Difference
Basic Fundamental Movement	Male	207	41.81	2.71	0.56
	Female	177	41.25	2.05	
Perceptual Ability	Male	207	41.99	3.37	-0.58
	Female	177	42.57	2.62	
Physical Ability	Male	207	43.64	2.15	-0.36
	Female	177	44.00	2.17	
Skilled Movement	Male	207	42.57	4.11	2.90
	Female	177	39.67	3.51	
Non-Discursive Communication	Male	207	44.64	2.05	0.43
	Female	177	44.21	2.34	
Overall PSAP	Male	207	214.66	6.55	2.95
	Female	177	211.71	5.60	

Table 1 shows that male students obtained slightly higher mean scores than female students in Basic Fundamental Movement, Skilled Movement, Non-Discursive Communication, and the overall PSAP score. Female students recorded slightly higher mean scores in Perceptual Ability and Physical Ability. The largest descriptive gender difference was observed in Skilled

Movement, where males outscored females by 2.90 points. Overall, male students scored 2.95 points higher than female students on PSAP.

Hypothesis 1

There is no significant difference in the mean overall psychomotor performance scores of male and female students in Physics as measured by PSAP.

Table 2: Independent-samples t-test of gender difference in overall PSAP scores

Gender	N	Mean	SD	t	df	p	Mean Difference
Male	207	214.66	6.55	4.68	382	< .001	2.94
Female	177	211.71	5.60				

The result in Table 2 shows a statistically significant difference in overall PSAP scores between male and female students, $t(382) = 4.68$, $p < .001$. The null hypothesis was therefore rejected. Male students performed

significantly better than female students on the overall PSAP score. Based on the reported means and pooled standard deviation, the magnitude of the difference was moderate ($d \approx 0.48$).

**Research Question 2**

What differences exist between students from urban and rural schools in psychomotor

performance in Physics as measured by PSAP and its subscales?

Table 3: School location differences in students' psychomotor performance in Physics as measured by PSAP and its subscales

Subscale	Location	N	Mean	SD	Mean Difference
Basic Fundamental Movement	Urban	202	41.73	2.63	0.03
	Rural	182	41.70	2.30	
Perceptual Ability	Urban	202	42.23	3.36	-0.24
	Rural	182	42.47	2.60	
Physical Ability	Urban	202	43.28	2.09	-1.14
	Rural	182	44.42	2.07	
Skilled Movement	Urban	202	43.30	3.65	4.28
	Rural	182	39.02	3.37	
Non-Discursive Communication	Urban	202	44.54	2.09	0.22
	Rural	182	44.32	2.30	
Overall PSAP	Urban	202	215.15	6.46	3.19
	Rural	182	211.96	5.77	

Table 3 indicates that urban students obtained slightly higher mean scores than rural students in Basic Fundamental Movement, Skilled Movement, Non-Discursive Communication, and the overall PSAP score. Rural students scored slightly higher in Perceptual Ability and Physical Ability. The largest descriptive location difference appeared in Skilled Movement, where urban

students outscored rural students by 4.28 points. Overall, urban students scored 3.19 points higher than rural students on PSAP.

Hypothesis 2

There is no significant difference in the mean overall psychomotor performance scores of students from urban and rural schools in Physics as measured by PSAP.

Table 4: Independent-samples t-test of school location difference in overall PSAP scores

Location	N	Mean	SD	t	df	p	Mean Difference
Urban	202	215.15	6.46	5.08	382	< .001	3.19
Rural	182	211.96	5.77				

Table 4 shows a statistically significant difference in overall PSAP scores between urban and rural students, $t(382) = 5.08$, $p < .001$. The null hypothesis was therefore rejected. Urban students performed significantly better than rural students on the

overall PSAP score. The magnitude of this difference was also moderate ($d \approx 0.52$).

Discussion

This study examined gender and school location differences in students' psychomotor skills in Physics as measured by the Psychomotor Skills Assessment in



Physics (PSAP). The findings showed that male students had a significantly higher overall PSAP score than female students. Descriptively, males performed better in Basic Fundamental Movement, Skilled Movement, and Non-Discursive Communication, whereas females showed slightly higher mean scores in Perceptual Ability and Physical Ability. The most notable descriptive difference between the two groups occurred in Skilled Movement.

The gender finding suggests that psychomotor performance in Physics may be influenced not simply by students' presence in the laboratory, but by the kinds of roles and actions they perform during practical work. This interpretation is consistent with the work of Day et al. (2016), who found that laboratory participation often becomes gendered in practice, with male students more likely to dominate equipment-related tasks. It is also in line with Fernandez et al. (2023), who reported that female students in practical settings often spend more time writing or recording rather than handling apparatus. The present result therefore supports the argument of Doucette and Singh (2024) that gender inequity in Physics laboratories is often expressed through differences in direct hands-on opportunity rather than mere attendance.

At the same time, the descriptive subscale pattern in this study shows that gender differences were not uniform across all aspects of psychomotor performance. Female students recorded slightly higher mean scores in Perceptual Ability and Physical Ability, suggesting that the gender effect may be stronger in some dimensions than in others. This is an important finding because it cautions against broad conclusions that one gender is categorically superior in all forms of practical performance. Instead, it suggests that specific task conditions, access patterns,

and instructional arrangements may shape performance outcomes. It also implies that classroom practice should be structured to ensure that both male and female students participate actively in apparatus handling, measurement, and coordinated laboratory execution.

The study also found a significant difference in overall psychomotor performance between urban and rural students, with urban students scoring higher on PSAP. Descriptively, urban students outperformed rural students in Basic Fundamental Movement, Skilled Movement, Non-Discursive Communication, and overall PSAP score, while rural students scored slightly higher in Perceptual Ability and Physical Ability. As with gender, the largest descriptive location difference was observed in Skilled Movement.

This finding suggests that the development of psychomotor competence in Physics may be closely linked to students' practical learning environment. Skilled Movement involves the coordinated and efficient execution of laboratory tasks, and this kind of performance is likely to be strengthened by repeated exposure to apparatus, structured supervision, and better-equipped learning environments. The higher performance of urban students may therefore reflect differences in access to laboratory resources and practical opportunities. This interpretation agrees with Adebisi and Ayoola (2024), who reported that rural students had lower exposure to practical teaching resources than urban students. It also aligns more broadly with Echazarra and Radinger (2019), who noted that rural–urban disparities in educational opportunity often persist even when academic comparisons are made under similar formal conditions.

However, the present result differs from Abamba (2021), who found that school



location did not significantly affect Physics achievement under the 5E learning cycle. One possible reason for this difference is that the present study focused specifically on psychomotor performance, not general academic achievement. It is possible for students to achieve similar cognitive outcomes while still differing in their hands-on competence, especially where access to equipment and opportunities for repeated manipulation vary across school settings.

A key implication of the present findings is that psychomotor assessment in Physics can reveal important patterns that are not always visible through conventional written tests. By using PSAP as a direct performance-based instrument, this study was able to show that both gender and school location were associated with meaningful differences in students' observable practical competence. This supports the position of Chabalengula et al. (2009) that the actual performance of scientific tasks should be assessed directly rather than inferred solely from written reports.

It is important to note, however, that the inferential analyses in this study were conducted on the **overall PSAP score only**. Although subscale mean differences were presented descriptively, subscale-specific significance tests were not conducted in the present analysis. The subscale patterns should therefore be interpreted cautiously and may serve as useful directions for future research.

Conclusion

The study showed that students' psychomotor skills in Physics, as measured by PSAP, differed significantly by both gender and school location. Male students obtained significantly higher overall psychomotor performance scores than female students, while urban students scored significantly higher than rural students.

Descriptive subscale patterns further suggested that the most pronounced differences occurred in Skilled Movement. These findings indicate that students' opportunities for direct engagement with practical Physics tasks may not be evenly distributed across gender groups and school environments. The study therefore underscores the need for more equitable and more deliberately structured practical experiences in secondary school Physics.

Implications of the Study

The findings of this study have practical implications for Physics teaching and assessment.

1. First, teachers should ensure that practical work is organized in ways that give all students equal access to apparatus handling, setup, and execution of laboratory procedures. This is especially important in mixed-gender settings where task roles may become informally divided.
2. Second, school administrators and policymakers should strengthen practical learning conditions in rural schools by improving laboratory facilities, access to equipment, and opportunities for repeated hands-on engagement.
3. Third, assessment in Physics should move beyond written practical reports to include direct observational measures of students' psychomotor performance. Instruments such as PSAP provide a more authentic basis for evaluating what students can actually do during laboratory work.

Recommendations

Based on the findings, the following recommendations are made:

1. Physics teachers should organize practical activities in ways that give both male and female students equal



- opportunities to handle apparatus and perform laboratory tasks.
2. School administrators and education authorities should provide more support for rural schools, especially in the area of laboratory facilities and practical learning resources.
3. Physics practical assessment should include direct observation of students' psychomotor performance so that differences in practical competence can be properly identified and addressed.

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