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The Functionality of National Examinations Council Senior School Certificate Physics Practical Examination Items

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Abstract

The study determined how the Senior School Certificate (S.S.C.) Physics Practical NECO examination items function differentially between male and female students and estimated the differential item functioning of the S.S.C. Physics Practical test items based on school type. It also ascertained the functionality of S.S.C. Physics Practical examination items between rural and urban dweller students. The research design adopted in this study was the descriptive survey research design. The population for the study was made up of all Senior Secondary Three (SS III) Physics students of Osun State in the 2017/2018 academic session—a total of 631 students selected through a multistage sampling procedure made up the sample. The NECO 2018 S.S.C. physics practical examination items were used to collect relevant data for the study. The chi-square likelihood ratio DIF method was adopted, and the mirt package was used for the analysis of collected data. The results showed that the proportion of DIF detected in the S.S.C. Physics practical examination under consideration was 8% (3 items) for sex, 5.4% (2 items) for type school and 32.4% (12 items) for school location. The study concluded that NECO physics practical examination items flagged moderately high incidence DIF with the location of the students. It is, therefore, recommended that NECO and other examination bodies that conduct such practical test needs to be conscious of students' location during test construction.

Keywords
national examinations; senior school certificate; physics practical

I. Introduction

One of the various difficulties that teachers have is capturing and sustaining students' interest in Physics. A lot of studies have revealed that Physics education is faced with the same issues everywhere around the world. This is supported by Mac Dermott (1998), who found that students from various cultural backgrounds and social classes understand Physics subjects differently. Juan and Ruiz (2009) conducted research on the totalization of didactic teaching-learning processes in Physics. The study discovered that teaching and studying Physics is difficult due to the fact that it has been mostly confined to the classroom. He also discovered that the teaching focused primarily on the cognitive domain, with little or no attention paid to the affective-emotional domain, rather than the psychomotor domain (practical skills), which sharpens students' powers of observation, stimulates questions and improves the effectiveness of new knowledge for technological advancement. Based on the preceding, it is critical to alter teaching methods in order to improve and make teaching Physics subjects more meaningful. It's also worth mentioning that there's a distinction made between what's taught in terms of theory and what's taught in terms of practice. The practical is taught separately from the theoretical, which does not help students learn concepts. Teaching should include a practical component, and theory should be derived from the practical (Juan & Ruiz 2009). In secondary school, students do practical work, laboratory experiments, demonstrations, fieldwork, and excursions are all used to teach physics. Teacher initiative and innovation could give rise to new types of practical investigations.

In addition to a relevant theory and objective examination, physics students in Nigeria are required to write a two-and-a-half-hour practical work assessment in their last year of secondary school. The National Examination Council (NECO), which is in charge of evaluating applicants at the secondary school level, creates this examination for Senior Secondary School Students in their third year of secondary school. Students must take an experimental work examination and complete a practical work paper, according to the physics syllabus for 'O' level students (2009). The grade is based on the practical work report presented at the end of the practical work exam.

Students must perform three actual job projects in total during this program. The activities include mechanics, electricity, and one design practical generated from any other section of the syllabus, such as light or optics. Students are typically subjected to weekly or biweekly practical evaluations in the laboratory as a way of preparing them for the final practical work assessment during their three years of secondary study. The technician leads the practical sessions with minimal assistance from the physics. Students will be expected to learn manipulation, observation, and design abilities, among other things. According to NECO physics marking guides, marks are given mostly for precise tabulation of data, graphical work, and interpretation of data at the expense of abilities such as preparation, equipment handling, and observation, among others.

In the teaching and learning of science, practical experience is a must. Practical experience, according to Millar (2004), aids students' understanding of how scientists work. In order to get the desired results, learning must be contextualized. The practical practice places students' learning in many stages of inquiry, where they are both mentally and physically engaged, if and when it is well-planned and well-carried out (Lunnetta, Hofstein, & Clough, 2007). Reasoning for practical work, according to Dillon (2008), requires both cognitive and skill development (manipulation, observation, measurement, prediction, and inference), Motivating pupils and fostering scientific thinking skills, as well as clarifying theoretical material so that students may understand it.

Practical work can be used as a training technique by students, especially in the field of problem-solving. The claim of Stacey and Spielman (2017) that experiments are the nature of science might be used to support this idea, as studying science without doing practical work would be like studying literature without books. These are only a few examples of how important practical work is in science education and learning, especially in physics, and how important it is to evaluate practical work in a way that maximizes results. How do practical abilities like equipment manipulation, for example, help you? In secondary schools, how observation and design are rated has a significant impact on how they develop. Assessing practical work in physics has always been challenging, according to Mathews and McKenna (2015) and Kennedy and Bennett (2005).

It's vital to identify practical skills that students will need in the real world. Despite the fact that practical skills in science are highly appreciated and discussed extensively in the literature, Reiss, Abrahams, and Sharpe (2012) argue that there needs to be more clarity on what these talents are and how they should be validly assessed most appropriately. Physics is complete with practical analysis, and it should be assessed as such. Some scientific teachers, for instance, have been observed and shown to be only instructing pupils in order to prepare them for tests. Such academics have struggled to improve their students' real-world competencies. Students in this type of teaching and learning environment would need more proper attitudinal training, which would help them in real-life situations such as finding work. According to Gopal and Stears (2007), assessments alone are unable to capture all learning outcomes. Gott and Roberts (2007) Students must be involved in the development and application of scientific knowledge. Student evaluation should be based on student behaviors rather than reports, according to this approach.

The sciences aren't the only ones that do practical work. It can also be used in other parts of the school curriculum. Fine arts and manual arts, for example, have a practical component. In the fine arts (for example, music), this is strongly linked to both respect and performance. The manual arts, on the other hand, place a strong emphasis on success.

School sciences fall right in the middle of these two extremes. The goal definitions for school practical work in science are less technique-oriented than those in the manual arts, despite some ambiguity in the sphere of recognition. In fact, most modern curricula have tended to minimize the skill-techniques component of science practical work in favor of an exploratory focus.

Science educators have been fascinated by the relative relevance of the goals or objectives for practical activity in the sciences since before the turn of the century. These goals are closely tied to the survival of the scientific effort. Modern science is defined as a systematically organized body of checked facts and relationships that covers a wide range of fields of study in that material; however, some science educators prefer to define science as a quest for truth through carefully supervised observation and experiment: an inductive method of investigation. Collette (1973) defines science as "a cumulative and infinite sequence of empirical data used in the formulation of conceptions and hypotheses, all of which are susceptible to change" in light of new scientific findings in his study of science teaching in secondary schools in the United States. Collette's naive intuitivist view of science is a work in progress. Though theories are based on experiments, they do not necessarily derive from them; it is a reasonable generalization for the vast majority of scientific research. In 'Science for Children,' published in 1974, Collette and Hubler consider the essence of science both historically and recently. According to educational psychologists, experimental work is crucial for a variety of reasons related to the mechanisms by which students learn.

Most early learning, according to Piaget and his colleagues at General Hospital, requires the internalization of the learner's physical behavior, implying the need for tangible experience. Much of the current emphasis on "action approaches" and practical experience is based on this type of theoretical reasoning. Bruner's (1960) concept of heuristics, or learning through discovery, highlights the major goals of science training as the development of research skills and experimental discovery procedures.

Students have a tremendous desire to learn about the world, according to him, but their comprehension is concrete rather than schematic or abstract. Student learning processes, according to Hubler (1974), are strikingly comparable to scientific techniques in which new understandings are formed through observation and experimentation. Students might benefit from conducting their study. According to Hubler, this is the most popular and effective way for students to study.

Many science educators agree with Piaget, Bruner, Hubler, and Collette that scientific processes and procedures should be represented in science education. As a result, their work will function as an implicit, if not clear, effective recommendation for a practical-based science program. In his evaluation of teaching science in secondary schools in the United States, Burnett (1960) states that the laboratory should be the center of activity in scientific instruction, just as it is in professional scientists' work: ".. Critical thinking, analytical thinking, and focused thinking should all take place in the laboratory." Oxenhorn (1972) emphasized the relevance of experimental work in low-achieving classrooms in his study 'Teaching Science to Under Achievers in Secondary School' in the United States. According to Oxenhorn, low achievers are not driven by abstract concepts; hence, real application is the best employment for them.

He emphasizes that practical application does not negate the importance of theory and concepts. In the use of rulers, weights, thermometers, liquid measurement devices, glass bending, equipment construction, and a variety of other laboratory skills, he believes that manipulative talents are crucial. Oxenhorn's concern for underachievers raises the bigger question of whether classroom science, which is designed to create fundamental scientific literacy rather than a sophisticated understanding of science, is linked to the needs of underachievers. Furthermore, scientific literacy is required by more students than just those pursuing science and technology careers.

National Examinations Council Chief Examiners‟ Report for 2016, 2017, and 2018 draw the attention of all stakeholders to the fact that students are not performing to expectation in practical Physics. The Chief Examiner over the three years reported that students are exhibiting problems across all the three categories in the Physics practical (Mechanics, Optics/Light and Electricity). Other related problems identified included: wrong responses to questions bordering on the theory of the experiment, inability to plot graphs involving small values and make deductions from the graphs. These findings as enumerated in the NECO Chief Examiners‟ Report, indicate that students do not have the requisite skills in Physics practical.

However, the Chief Examiner’s reports over the years failed to identify how students performed on each of the items based on variables such as sex, school type and school location. In other words, the report needed to have identified the functionality of the physics practical examination items. Functionality of an item is obtained through the use of Differential item functioning (DIF) method(s). DIF is established when subgroups perform differently on a test item after it has been matched on a construct that the test measures. Equity and fairness of educational assessments are ensured by DIF analysis. This is because tests that do not display DIF are regarded to be equitable and fair to all examinees. Wyse and Mapuranga (2009) were of the opinion that "In real testing situations, the existence of DIF is an important practical and ethical concern given the relationship of DIF analysis to the legal and policy considerations for society’s traditionally disadvantaged groups." Therefore, DIF analyses are majorly focused on investigating if test items are functioning differently for subgroups by comparing advantage group performance, that is, the reference group, with the performance of the disadvantaged group, that is, the focal group. Not ascertaining the functionality of the Physics practical examination items might be one of the reasons students continue to perform poorly in Physics. Therefore, the differential item functioning of the Senior School Certificate Physics practical examination conducted by the National Examinations Council (NECO) is still being determined; thus, this study.

1.1 Purpose of the Study

The broad objective of this study is to establish the functionality of S.S.C. Physics practical examination items for the measurement of practical skills proficiency in the students. Specifically, the objectives of the study are to:

1. Determine how the S.S.C. Physics Practical NECO examination items function differentially between male and female students;

2. Estimate the differential item functioning of the SSCE Physics Practical test items based on school type and
3. Ascertain the functionality of S.S.C. Physics Practical examination items between rural and urban dweller students.

1.2 Research Questions

1. How do senior school certificate Physics practical National Examinations Council examination items function between male and female students?
2. What is the estimated differential item functioning of the S.S.C. Physics practical test items with respect to school type?
3. What is the functionality of S.S.C. Physics Practical examination items between rural and urban dweller students?

II. Research Methods

The research design adopted in this study was the descriptive survey research design. The population for the study was made up of all Senior Secondary Three (SS III) Physics students of Osun State in the 2017/2018 academic session. A total of 631 students selected through a multistage sampling procedure made up the sample used in the study. Five Local Government Areas (L.G.A.s) were chosen at random from each of the three senatorial districts of the State. Non-proportional stratified random sampling was used to select four schools from each of the L.G.A.s, with school ownership as the basis for stratification. All SSIII Physics students in the selected schools in the academic session made up the sample size of 661 students. The NECO 2018 S.S.C. physics practical examination items were used to collect relevant data for the study. The chi-square likelihood ratio DIF method was adopted, and the mirt package was used for the analysis of collected data.

III. Resultds and Discussion

3.1 Results

To answer this research question, the responses of the examinees were subjected to differential item functioning with the identifiable sub-groups as the grouping variable. To achieve the assessment of the differential item functioning, the Chi-square likelihood ratio DIF method was adopted, and the mirt package was used for the analysis. An item is considered to function differential with respect to a particular subgroup when the Chi-square value for the item is significant (i.e., the functionality of the item with respect to the two independent groups in question is significantly different). The item will be adjudged free of DIF if the Chi-square value for the item is not significant (i.e., the functionality of the item with respect to the two independent groups in question is not significantly different). The result is presented question by question as follows.

Research Question 1: How do senior school certificate Physics practical National Examinations Council examination items function between male and female students?

Table 1. Differential Item Functioning of NECO SSSCE Physics Practical Test with Respect to Sex

S/N	Item	X2	df	p-value	Remark
1	Q1_ai	4.391	1	0.036	DIF
2	Q1_aii	4.495	1	0.034	DIF

3	Q1_aiii	5.043	1	0.025	DIF
4	Q1_aiv	3.12	1	0.077	NO DIF
5	Q1_av	3.213	1	0.073	NO DIF
6	Q1_avi	6.73	1	0.009	DIF
7	Q1_avii	4.193	1	0.041	DIF
8	Q1_Graph	1.006	1	0.316	NO DIF
9	Q1_Slope	4.024	1	0.045	DIF
10	Q1_Evaluation	2.215	1	0.137	NO DIF
11	Q1_Precaution	3.078	1	0.079	NO DIF
12	Q1_bi	3.365	1	0.067	NO DIF
13	Q1_bii	1.375	1	0.241	NO DIF
14	Q2_ai	2.75	1	0.097	NO DIF
15	Q2_aii	2.6	1	0.107	NO DIF
16	Q2_aiii	1.818	1	0.178	NO DIF
17	Q2_aiv	1.678	1	0.195	NO DIF
18	Q2_av	1.69	1	0.194	NO DIF
19	Q2_avi	1.42	1	0.233	NO DIF
20	Q2_Graph	1.127	1	0.288	NO DIF
21	Q2_Slope	2.539	1	0.111	NO DIF
22	Q2_Precaution	1.772	1	0.183	NO DIF
23	Q2_bi	1.166	1	0.28	NO DIF
24	Q2_bii	0.694	1	0.405	NO DIF
25	Q3_ai	3.516	1	0.061	NO DIF
26	Q3_aii	1.731	1	0.188	NO DIF
27	Q3_aiii	1.304	1	0.253	NO DIF
28	Q3_aiv	2.465	1	0.116	NO DIF
29	Q3_av	0.733	1	0.392	NO DIF
30	Q3_avi	3.397	1	0.065	NO DIF
31	Q3_Graph	4.678	1	0.031	DIF
32	Q3_Slope	1.302	1	0.254	NO DIF
33	Q3_Intercept	10.651	1	0.001	DIF
34	Q3_Evaluation	2.681	1	0.102	NO DIF
35	Q3_Precaution	2.288	1	0.13	NO DIF
36	Q3_bi	1.214	1	0.27	NO DIF
37	Q3_bii	1.341	1	0.247	NO DIF

Table 1 shows the DIF of the NECO SSCE Physics practical test items with respect to sex. The table showed that item 1 functioned differentially with respect to sex. That is, the functionality of the item among male and female students differed significantly (χ^2 $(1) = 4.391, p < 0.05$). Similarly, the table showed that items 2, 3, 6, 7, 9, 31 and 33, respectively, functioned differentially with respect to sex. The table further showed that the remaining 29 items (4, 5, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 32, 34, 35, 36 and 37) functioned similarly with respect to sex. The result showed that most of the items functioned similarly among male and female students. The result implies that the incidence of DIF of the items of the NECO SSSCE Physics practical test with respect to sex was very low.

Research Question 2: What is the estimated differential item functioning of the S.S.C. Physics practical test items with respect to school type?

Table 2. Differential Item Functioning of NECO SSSCE Physics Practical Test with Respect to School Location

S/N		X2	df	P	
1	Q1_ai	11.705	1	0.001	DIF
2	Q1_aii	0.862	1	0.353	NO DIF
3	Q1_aiii	2.85	1	0.091	NO DIF
4	Q1_aiv	1.723	1	0.189	NO DIF
5	Q1_av	1.229	1	0.268	NO DIF
6	Q1_avi	0.94	1	0.332	NO DIF
7	Q1_avii	0.614	1	0.433	NO DIF
8	Q1_Graph	3.748	1	0.053	NO DIF
9	Q1_Slope	6.886	1	0.009	DIF
10	Q1_Evaluation	1.444	1	0.229	NO DIF
11	Q1_Precaution	2.126	1	0.145	NO DIF
12	Q1_bi	2.521	1	0.112	NO DIF
13	Q1_bii	1.962	1	0.161	NO DIF
14	Q2_ai	3.628	1	0.057	NO DIF
15	Q2_aii	3.222	1	0.073	NO DIF
16	Q2_aiii	2.55	1	0.11	NO DIF
17	Q2_aiv	1.806	1	0.179	NO DIF
18	Q2_av	1.933	1	0.164	NO DIF
19	Q2_avi	2.076	1	0.15	NO DIF
20	Q2_Graph	1.788	1	0.181	NO DIF
21	Q2_Slope	0.833	1	0.361	NO DIF
22	Q2_Precaution	0.932	1	0.334	NO DIF
23	Q2_bi	1.456	1	0.228	NO DIF
24	Q2_bii	0.782	1	0.376	NO DIF
25	Q3_ai	2.644	1	0.104	NO DIF
26	Q3_aii	1.532	1	0.216	NO DIF
27	Q3_aiii	1.97	1	0.16	NO DIF
28	Q3_aiv	0.868	1	0.352	NO DIF
29	Q3_av	1.565	1	0.211	NO DIF
30	Q3_avi	0.588	1	0.443	NO DIF
31	Q3_Graph	2.191	1	0.139	NO DIF
32	Q3_Slope	0.558	1	0.455	NO DIF
33	Q3_Intercept	0.583	1	0.445	NO DIF
34	Q3_Evaluation	2.672	1	0.102	NO DIF
35	Q3_Precaution	2.527	1	0.112	NO DIF
36	Q3_bi	0.853	1	0.356	NO DIF
37	Q3_bii	0.765	1	0.382	NO DIF

Table 2 shows the DIF of the NECO SSCE Physics practical test items with respect to school location. The table showed that item 1 functioned differentially with respect to school location. That is, the functionality of the item among urban and rural school students differed significantly ($\chi^2\ (1) = \ 11.705, p < 0.05$). Similarly, the table showed that item 9 functioned differentially with respect to school location. That is, the functionality of the item among urban and rural school students differed significantly ($\chi^2\ (1) = \ 6.886, p < 0.05$) . The table further shows that the remaining 35 items (2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 32, 33, 34, 35, 36 and 37) functioned similarly among rural and urban schools. The result showed that most of the items functioned similarly among students whose schools are located in rural and urban settings. The result implies that the incidence of DIF of the items of the NECO SSCE Physics practical test with respect to school location was very low.

Research Question 3: What is the functionality of S.S.C. Physics Practical examination items between rural and urban dweller students?

Table 3. Differential Item Functioning of NECO Physics Practical Test with Respect to School Type

S/N	Item	χ^2	df	P	Remark
1	Q1_ai	1.528	1	0.216	NO DIF
2	Q1_aii	3.492	1	0.062	NO DIF
3	Q1_aiii	5.958	1	0.015	DIF
4	Q1_aiv	5.293	1	0.021	DIF
5	Q1_av	1.54	1	0.215	NO DIF
6	Q1_avi	4.529	1	0.033	DIF
7	Q1_avii	2.058	1	0.151	NO DIF
8	Q1_Graph	2.379	1	0.123	NO DIF
9	Q1_Slope	5.107	1	0.024	DIF
10	Q1_Evaluation	2.02	1	0.155	NO DIF
11	Q1_Precaution	1.423	1	0.233	NO DIF
12	Q1_bi	2.145	1	0.143	NO DIF
13	Q1_bii	2.861	1	0.091	NO DIF
14	Q2_ai	8.18	1	0.004	DIF
15	Q2_aii	12.296	1	0	DIF
16	Q2_aiii	5.953	1	0.015	DIF
17	Q2_aiv	3.914	1	0.048	DIF
18	Q2_av	3.446	1	0.063	NO DIF
19	Q2_avi	2.115	1	0.146	NO DIF
20	Q2_Graph	3.935	1	0.047	DIF
21	Q2_Slope	3.183	1	0.074	NO DIF
22	Q2_Precaution	4.815	1	0.028	DIF
23	Q2_bi	3.896	1	0.048	DIF
24	Q2_bii	3.042	1	0.081	NO DIF
25	Q3_ai	6.585	1	0.01	DIF
26	Q3_aii	4.874	1	0.027	DIF
27	Q3_aiii	1.571	1	0.21	NO DIF
28	Q3_aiv	2.344	1	0.126	NO DIF

29	Q3_av	2.688	1	0.101	NO DIF
30	Q3_avi	1.949	1	0.163	NO DIF
31	Q3_Graph	1.894	1	0.169	NO DIF
32	Q3_Slope	1.339	1	0.247	NO DIF
33	Q3_Intercept	2.068	1	0.15	NO DIF
34	Q3_Evaluation	2.155	1	0.142	NO DIF
35	Q3_Precaution	2.909	1	0.088	NO DIF
36	Q3_bi	3.515	1	0.061	NO DIF
37	Q3_bii	2.144	1	0.143	NO DIF

Table 3 shows the DIF of the NECO Physics practical test items with respect to school type. The table showed that item 3 functioned differentially with respect to school type. That is, the functionality of the item among private and public school students differed significantly (χ^2 $(1) = 5.958, p < 0.05$). Similarly, the table showed that items 4, 6, 9, 14, 15, 16, 17, 20, 22, 23, 25 and 26 functioned differentially with respect to school location. The table further showed that the remaining 25 items (1, 2, 5, 7, 8, 10, 11, 12, 13, 18, 19, 21, 24, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36 and 37) functioned similarly among private and public schools. The result showed that most of the items functioned similarly among students who are from school in private and public schools. The result implies that the incidence of DIF of the items of the NECO SSSCE Physics practical test with respect to school location was low.

3.2 Discussion

In this study, an important factor considered was to determine how students' varying ability distributions based on belonging to reference and focal groups impact DIF, according to Donoghue, Holland and Thayer (1993) as well as Jodoin and Gierl (2001). In this study, the effects of the potential disparities were based on a level of ability distribution that speculated that both reference and focal groups were considered to have identical ability distributions. Thus, the reference and focal groups were drawn from a standard normal distribution (i.e., N (0,1)) — called equivalent ability. The study also investigated the proportion of DIF in the S.S.C. Physic practical examination conducted by NECO; this was in line with Jodoin and Gierl (2001). Considering the identical ability distributions, the proportion of DIF detected in the S.S.C. Physics practical examination under consideration was 8% (3 items) for sex, 5.4% (2 items) for type school and 32.4% (12 items) for school location. The findings of the study implied the incidence of DIF of the items of the NECO SSCE Physics practical test with respect to sex and school type was very low, but it was moderately high between urban and rural school students.

IV. Conclusion

The study concluded that NECO physics practical examination items flagged relatively very low DIF when the sex and school of the students were considered but moderately high incidence DIF with the location of the students. It is, therefore, recommended that NECO and other examination bodies that conduct such practical tests during the construction of examination items be conscious of students’ location to ensure that subgroups do not perform differently on a test item after being matched on a construct measured by the test.

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