

Influence of Cognitive Style and Gender on Students' Academic Achievement in Physics at Secondary School Level in Adamawa State, Nigeria.

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ABSTRACT

The study investigated the influence of cognitive style and gender on students' achievement in Physics at secondary school level in Adamawa State. Four hypotheses guided the study. The study employed an ex-post facto design. A sample of 450 SSS II students from 19,800 SSS II students were selected using simple random sampling technique. The instruments used for data collection were Physics Achievement Test (PAT) for measuring achievement in physics and the Group Embedded Figure Test (GEFT) which was adopted to determine students' cognitive styles. Reliability coefficients of 0.74 and 0.89 for PAT and GEFT were obtained respectively. Hypotheses one, two and three were tested using t - test statistic while hypothesis four was tested using two - way ANOVA at 0.05 alpha level. The findings of the study showed that, (i) there was statistical significant difference between field dependent and field independent students' academic achievement in physics ($z_{(448, 0.05)} = 9.406, p < 0.05$) in favour of field independent students (ii) there was statistical significant gender difference of field dependent students' academic achievement in physics ($z_{(146, 0.05)} = 6.019, p < 0.05$) in favour of the male field dependent students. (iii) there was statistical significant gender difference of field independent students' academic achievement in physics ($z_{(300, 0.05)} = 10.490, p < 0.05$) in favour of the male field independent students (iv) there was no significant interaction influence of cognitive style and gender on students' achievement in physics. Based on the findings, it was recommended that teachers should consider students' cognitivestyles and their gender in the planning and delivery of learning materials in physics while in-service training should be organized for physics teachers on how to identify students' cognitive styles.

Keywords: Field dependent, field independent, gender, academic achievement, GEFT

INTRODUCTION

Education is considered the first step for every successful human activity and the development of any nation relies largely on the quality of its education. This assertion is corroborated by [1,2] who stated that the economic and political strength of any nation depend on her scientific and technological achievement. Furthermore, [3] stressed that science is regarded as the foundation upon which the bulk of present day technological breakthrough is built. The impact of science is felt in every sphere of human endeavour so much that it is intricately linked with a nation's development [4]. The field of science comprises of basic disciplines including Physics, Chemistry, Biology and Mathematics [5]; all taught as component subjects at the secondary education level. The objectives of

studying physics in particular as contained in Nigeria's National Education Scheme designed for secondary school physics (2000) [6] include among others; to provide basic literacy in physics for functional living in the society and to acquire essential scientific skills and attitudes as a preparation for the technological application of physics. [7] believe that physics education is a major factor in enhancing technology development. Similarly, [8] assert that Physics is "sine qua non" to the technological development of any nation and it is the foundation upon which the scientific and technological advancement of any nation rests. [9] stressed that Physics is a vehicle for achieving the long-term goals of science because it is

instrumental to technological and socio-economic growth across the globe.

Physics is therefore a core subject in science and technology since it studies the essence of natural phenomena and helps people understand the rapidly technological changing society [10]. All technology is beholden to physics due to its emphasis on addressing phenomena involving the interaction of matter and energy. This interaction is necessary for the technological needs of the changing society [11]. The principles of Physics have been widely used for various economic, scientific and technological advancement such as in information and communication technology, which has reduced the world into a global village through the use of satellites and computers. Physics continues to influence applications in medicine. Medical methods including imaging techniques and diagnostics of patient screening techniques are based on physics principles [12]. Currently, a wide variety of treatment techniques are made possible by the discovery of radioactivity and other high frequency radiations. The unravelling of the DNA structure and the subsequent genome project required a significant input from physics techniques [13]. Computers, mobile phones and their attendant spin-off technologies show the indispensability of physics. Photonics and other quantum nanostructures show promise in terms of optical fibre based communication systems [14]. Laser applications are used in commerce and industry. Electromagnetism is vital in the generation of electricity, mobile phone communication, optical and satellite communication, portable electronics, radio and radar perception, and X-ray crystallography [15]. Also, the knowledge of physics had led to sustainable development in the area of industrialization for improvement of materials useful to the well being of the human race [16]. Bello also stressed that physics education enables the learners to acquire problem-solving and decision-making skills that pave way for critical thinking and inquiry that could help them to respond to widespread and radical changes in all facets of life.

Despite the importance of physics and its values which are relevant to the need of individual learners, economics and

technological breakthrough of a nation as well as the efforts of researchers to improve on its teaching and learning, the achievement of students is not encouraging [17]. [18], found that the achievement of Nigerian students in Ordinary Level physics was generally and consistently poor over the years. Students' academic outcome at all levels of education remains a top priority for educators. Educators, trainers, and researchers have long been interested in exploring variables contributing effectively to quality performance of learners. These variables may reside both inside and outside the school but significantly, influence students' quality of academic achievement. These factors may be termed as student factors, family factors, school factors and peer factors [19]. The foundation for better achievement in physics takes its root from the first year of the senior secondary school. The physics curriculum at this level emphasizes that students must be well developed at the lowest level of cognitive domain, if physics is to be well understood by them at their early introduction of the subject [20]. Lack of proper attention to the cognitive domain by respective physics teachers has led to students' perception of physics as difficult subject [21]. This had affected learners' interest and has subsequently led to decline in enrolment and under achievement in physics [22]. [23] has stated that a learner characteristic such as cognitive style is very critical in deciding students' academic outcome. The author added that cognitive style is considered as pattern of adjustment to the world [24].

Students' cognitive style and teachers teaching style influences students' academic achievement [25,26]. The way an individual perceives, organises and interprets information is a function of his or her cognitive style [27]. Some studies showed that sex differences exist between cognitive style and academic achievement [28]. In fact, cognitive style theory predicted that the female is more likely to have a social or field dependant cognitive style than their male counterpart whereas to some researchers such as [29] that reverse is the case as males are seen as more field dependent. [30] revealed that non-analytic boys scored significantly better

than the non-analytic girls and analytic boys scored significantly more than analytic girls. From the foregoing, it is glaring that research studies on cognitive style and its influence on students' achievement have been inconsistent and often contradictory. Based on these, it is therefore necessary

Statement of the Problem

In recent time, the educational sector has witnessed a rapid decrease in terms of students' population in Physics and other science subjects in senior secondary schools. The few students studying Physics do not pass the subject well in West African Senior Secondary School Certificate Examination (WASSCE) and National Examination Council (NECO) [32]. This view is corroborated by [33] who revealed that students' achievement in Physics has been generally poor over the years. This has raised concern among respective stakeholders in the nation. Parents' dissatisfaction on the achievement of their children in Physics in both internal and external examinations has continued to grow while the government seems to have no satisfactory answer to this problem. This has become a source of worry to Physics teachers in secondary schools across the country (particularly Adamawa State) that has remained at the receiving end of uncomplimentary accusations of inefficiency and gross incompetence. Besides, it has been found that many female science secondary students continue to be scared of offering Physics in the belief that the subject is a male dominated discipline [34], thus further widening the gender gap in science related fields. The question here is: does students' cognitive style influence academic achievement in Physics, bearing in mind their gender differences? This is necessary to be investigated further in order to curtail the persistent poor academic achievement which will hinder the technological development of the nation. This study therefore sought to determine the influence of cognitive

that more research be carried out to further shed light on how cognitive style may influence students achievement in Physics. According to [31] refusing to find out the cognitive style of learners is like administering of some drugs to an unknown ailment.

style and gender on students' academic achievement in Physics at the secondary school level in Adamawa State.

The study was guided by the following objectives:

1. To determine the influence of field dependent and field independent cognitive styles on secondary school students academic achievement in physics.
2. To ascertain the influence of gender difference of field dependent cognitive style on secondary school students academic achievement in physics.
3. To ascertain the influence of gender difference of field independent cognitive style on secondary school students academic achievement in physics.
4. To determine the interaction influence of cognitive style and gender on student' academic achievement in physics.

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

Ho₁ There is no significant difference between field dependent and field independent cognitive style students' academic achievement in physics.

Ho₂ There is no significant gender difference of field dependent cognitive style students' academic achievement in physics.

Ho₃ There is no significant gender difference of field independent cognitive style students' academic achievement in physics.

Ho₄ There is no significant interaction influence of cognitive style and gender on students' academic achievement in physics.

METHODOLOGY

This study employed the ex post facto design, this is because the independent variables had already occurred and no manipulation was done to them in the context of this study. In order to match

the variables, it adopted a 2 x 2 factorial matrix. A total population of 19,800 SS 11 science students in the public senior secondary schools spread across the five education zones of the State was

targeted out of which 450 participant were selected using simple random technique. Two instruments were employed for data collection, the Physics Achievement Test (PAT) which was used to determine students' academic achievement in Physics and Group Embedded Figure Test (GEFT) adopted from [35] and was used to categorized students cognitive styles. The PAT instrument was validated by three experts from MAUTECH Yola while the GEFT was validated on line, a reliability of 0.74 and 0.89 for PAT and GEFT was obtained respectively. Hypotheses one, two and three were

tested using t- test statistic while hypothesis four was tested using two - way ANOVA. All the hypotheses were tested at 0.05 level of significance. The t-test statistic was used to determine the statistical significance differences between cognitive styles (field dependent and field independent) and male and female students' academic achievement for hypothese one, two and three while two - way ANOVA was used to determine the interaction influence of cognitive style and gender on students' academic achievement for hypothesis four.

RESULTS AND DISCUSSION

H_{01} : There is no significant difference between field dependent and field independent cognitive style on

secondary school students' academic achievement in physics.

Table 1: t-test of Field Dependent and Field Independent Students' Achievement in Physics.

Cognitive Style	n	Mean	Std. Deviation	Df	t	P - value	Remark
Field Dependent	148	33.84	8.59	448	-9.41	0.000	Significant
Field Independent	302	40.88	6.84				

Table 1 shows summary of t - test conducted to test whether there is significant difference in the mean achievement scores of field dependent and field independent cognitive style students. The results showed that there is significant difference in the mean achievement scores of field dependent and field independent cognitive style

students ($t_{(448, 0.05)} = 9.41, p < 0.05$). From this result, it is concluded that field independent cognitive style students achieved significantly higher than field dependent cognitive style students.

Table 2: t- test Analysis of Male and Female Field Dependent Students' Achievement in Physics

Gender	n	Mean	Std. Deviation	Df	t	P - value	Remark
Male	148	33.84	8.59	146	6.01	0.000	Significant
Female	302	40.88	6.85				

Table 2 shows the summary of t-test conducted to test whether there is significant difference in the mean achievement scores of male and female field dependent students. The results showed that there is significant difference in the mean achievement scores of male and female students ($t_{(146, 0.05)} = 6.019, p < 0.05$). Based on this result

H_{02} : there is no significant gender difference of field dependent cognitive style on secondary school students' academic achievement in physics.

it can be concluded that male field dependent students achieved significantly than the female field dependent cognitive style students. H_{03} : There is no significant gender difference of field independent cognitive style on secondary school students' academic achievement in physics.

Table 3: t-test Analysis of Field Independent Male and Female Students' Achievement in Physics

Gender	n	Mean	Std Deviation	Df	t	P - value	Remark
Male	148	33.84	8.59	300	10.49	0.000	Significant
Female	302	40.89	6.85				t

Table 3 shows the summary of t-test conducted to test whether there is significant difference in the mean achievement scores of male and female field independent students. The results showed that there is significant difference in the mean achievement scores of male and female students ($t_{(300, 0.05)} = 10.490$, $p < 0.05$). Based on this

result it can be concluded that male field independent students achieved significantly more than the female field independent cognitive style students.

Ho4: There is no significant combined influence of cognitive style and gender on students' academic achievement in physics.

Table 4: Summary of Two - Way ANOVA of Cognitive Style and Gender on Students' Achievement in Physics

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	10876.920	3	3625.640	85.002	.000
Intercept	313613.515	1	313613.515	7352.540	.000
Cognitive style	50.982	1	50.982	1.195	.275
Gender	4948.513	1	4948.513	116.016	.000
Cognitive style and Gender	123.428	1	123.428	2.894	.090
Error	19023.580	446	42.654		
Total	699225.000	450			
Corrected Total	29900.500	449			

R Squared = .364 (Adjusted R Squared = .359)

Result in Table 4 shows the summary of two - way ANOVA conducted to test whether there is interaction influence of cognitive style and gender on the students' achievement in physics. The results showed that there is no significant interaction influence of cognitive style and gender on students'

achievement in physics, $F_{(1, 449)} = 2.89$, $p > 0.05$. Since the P-value is greater than 0.05 level of significance, the null hypothesis of no significant interaction influence is therefore not rejected. This implies that there is no significance interaction influence of cognitive style and gender on academic achievement of students in physics.

CONCLUSION

The findings of this study showed that field independent cognitive style influenced students' academic achievement in physics more compared to the field dependent cognitive style. The relative supremacy of the field independent cognitive style over field dependent cognitive style in this study could be due the fact that field independent cognitive style deals with the ability to separate parts from the whole which physics and other science

based subjects depend upon. This result is in agreement with the findings of [36,37] who in their separate studies found that field independent cognitive style has more significant influence on students' academic achievement in physics than field dependent cognitive style students. The finding, however, contradicted findings such as [38,39,40] who found that there is no significant influence of cognitive style (FI/ FD) on students' academic achievement in

physics. Based on this result, it could be inferred that field independent cognitive style has significant influence on students' academic achievement in physics, in favour of the field independent cognitive style students. The results of this study also showed that there is significant gender difference between field dependent and field independent students' academic achievement in physics in favour of the males. The superiority of males over the females in this study could be due gender stereotyping in our homes, schools and society as opined by [41]. The findings of this study is in conformity with studies by [42,43,44] all found that there is significant influence of gender on students academic achievement in Physics in favour of the males for both field dependent and field independent. However, the result of this study is contrary to findings by [45,46,47] amongst others who in their separate studies concluded that students' academic achievement in physics is free from gender bias. The disparities in these results call for further research on the influence of cognitive style and gender on students' academic achievement in physics at the secondary school level.

RECOMMENDATIONS

On the basis of findings emanating from this study, the following recommendations were made:

1. Physics teachers should strive to be aware of the type of cognitive style that their students possess for proper choice of effective teaching strategies/ methods
2. Physics teachers should therefore, adopt instructional strategies that will sustain gender equality in the teaching and learning of physics.

The results of this study also revealed that there is no significant interaction influence of cognitive style and gender on students' academic achievement in physics. The result of this study is in agreement with studies conducted by [48,49,50] who in their separate studies found no significant influence of cognitive style and gender on students' academic achievement in physics. Based on the findings of this study, it can be concluded that cognitive style and gender singly influenced students' academic achievement in physics at the senior secondary school level. Field independent cognitive style influenced students' academic achievement in physics more compared to field dependent cognitive style. Also male students achieved significantly more in physics compared to their female counterpart. It can be deduced that cognitive style and gender do no significant influence students' academic achievements in physics. Hence, it is hoped that when physics teachers consider students individual cognitive style and their gender in the process of teaching and learning of physics, it will no doubt enhance their academic achievement.

3. Physics teachers should consider individual students' gender and cognitive styles in preparing their instructional media and in the choice of teaching strategies/ methods so as to enhance their academic achievement in physics.

4. In - service training for physics teachers in form of seminars, workshops and conferences should focus more on how to handle students based on their cognitive styles and gender in the teaching and learning of Physics.

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