

Effects of Cognitive Styles and Understanding of Concept on Achievements of Students in Secondary School Physics Practical

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Abstract

The study sought to see the effect of cognitive styles and concept understanding on students' achievement in Secondary School Physics practical. It reveals the level of performance of students in Physics and how the students' cognitive styles and the level of concept understanding could influence their performance. Outcome of the study could enhance the learners' performance through the revelation of the significance of students' cognitive styles and concept understanding to both the learners and their teachers. This study used a quasi experimental research design with 2x2 non-randomized pretest and post test control group, factorial design to determine the effect of cognitive styles and concept understanding on achievement. Two hundred and forty Senior Secondary School two (SSS 2) students were involved. Multi-stage sampling technique was used to select four public and two private secondary schools in six Local Government Areas in Osun State. The schools were randomly assigned into experimental and control groups. The instruments used for data collection were Physics Practical Test (PPT) and Cognitive Test in Physics (CTP). A pre text was administered to determine the achievement level of the students in the two groups before the treatment. Students in the experimental group were exposed to concepts teaching- the symbolic concepts in the experiments, understanding of principles and laws that govern the experiments and understanding of concepts of mathematical language before the practical sessions for three weeks. A posttest was later administered on the two groups at the end of the treatment. Data collected were analyzed using ANCOVA. t- test was used to determine the significant difference in the achievements between the two groups. The study revealed that cognitive styles and concept understanding have significant effect on students' achievement, interaction effect of cognitive styles and concept understanding has significant effect on students' achievement. Based on the findings, it was recommended that teachers should give enough time to teach the concept of Physics practical before the activities of practical itself, considerable periods should be allotted to emphasize the mathematical concept before the practical class.

Keywords: physics, practical, cognitive, achievement, understanding

INTRODUCTION

The study of Physics revolves on intelligence, social and practical activities. The students' intelligence and social interaction in manipulating the real objects are interlocking to characterize the enterprise of Physics practical. Constructive learning in Physics practical emerges when significant intellectual development and social interaction converge within the context of the subject. Concrete processes such as observation, experimentation, measurement, and recording go along with Physics practical as opposed to the virtual world. Rakhee and Sharma (2013) asserted that demonstration of experiment is important for understanding the principles of physics and performing experiments by one's own hand is far more important because it involves learning by doing. According to Black (1993), doing science refers to developing procedures used in science laboratory practical activities. This study therefore examines the effects of cognitive styles and understanding of

concept on achievements of students in secondary school physics practical in Nigeria.

Myriad of empirical observation occurs during Physics practical which call for the usage of concepts. Physics concepts are expressed as symbol, words, law, theory, principle and mathematical language. Johnstone (1991) asserted that science can be understood at three different levels at each increasingly complexity: the phenomena (macroscopic), the particle (Microscopic), and the symbolic. Macroscopic concepts are observable, microscopic concepts are abstraction while symbolic concepts are mathematically represented. Students cannot do without the usage of these concepts during Physics practical. Vigotsky (1978) remarks that learning involves language and that the language we use influence learning; on the empirical level, he says, researchers have noted that people talk to themselves as they learn, and that language and learning are interwoven. Physics practical problems

are solved through mathematical language, so mathematical language is an important concept to be known and applied correctly.

Students cannot fully integrate Physics concept unless the distinctive potential of cognitive styles are used in the practical class. The concept of cognitive style is defined by Kozhevnikov (2007) to represent heuristics that individual use to process information about their environment. These are characterized in the potentials like awareness, perception, intelligence, rationality, will power and problem solving abilities of students. Goldstein and Blackman (1978) define cognitive style as “a hypothetical construct that has been developed to explain the process of mediation between stimuli and responses. The term cognitive style refers to characteristic ways in which individuals conceptually organize the environment. Cognitive style on the whole involves personality and cognitive processes. Cognitive style simply means the approach of taking, processing and using information appropriately depending on perceptual modalities. Cognitive research has shown that learning is most effective when four fundamental characteristics are present. The characteristics include: Active engagement, Participation in groups, frequent interaction and feedback and Connection to real world contexts (Newman, 2004).

One recent attempt to simplify the cognitive underpinnings of cognitive styles was a characterization of the field dependence – independence (Miyake, Witzki and Emerson 2001). Field independence is also known as analytical style, Agor (1984) asserted that analytical students prefer to solve problems by breaking them into manageable parts by using analytical and qualitative technique. Analytical with this possess the ability to identify, associate or differentiate stimuli in their perceptual field. Such learners will conveniently define the problem from complex stimuli, make necessary correlation between the selected information from the observed and concept learnt. Hence, which calls for reflectivity in their approach. Singh & O’Boyle (2004) see the field independent students having a more piecemeal, analytical style and experience with less interference from distracters, when attending to visual stimuli.

The analytical fully utilizes memory, abstraction and synthesization which make them to stand out. According to Wallace (1971), memory factor refers to the ability to store and recall while abstraction is the ability to classify information and experience in such a way that is linked with interlocking concept and Synthesization is the process of creating new information on the basis of logical induction.

Non-analytical students shared the opposite characteristics to analytic in terms of globalization of

their perception, with a problem at distinguishing out parts of their perceptual field from the whole. The fallout in abstraction and synthesization accounted for their impulsive learning styles.

STATEMENT OF PROBLEM

Among other sciences, the poor academic achievement in Physics at the Senior Secondary may not be unconnected with the Physics practical activities. Reasons for this are lack of concept knowledge to be used by the students during Physics activities, the understanding of concept of mathematical language and symbolic logics play indispensable role which determine students’ achievement in Secondary School Physics practical.

Consequently, students are not well grounded in their critical minds to display and transmit desired cognitive ability expected in the practical activities. This has equally contributed to in the gap created in analyzing their results which has a greater bearing to the achievement of Physics practical.

Research Questions

The following research questions were raised for the purpose of the study:

1. What is the main effect of concept understanding and cognitive styles on students’ achievement?
2. What is the effect of analytical and non-analytical styles on students’ achievement?
3. What is the 2-way interaction effect of concept understanding and cognitive styles on students’ achievement?

SIGNIFICANCE OF THE STUDY

The results of the study on the main and interaction effects of concept understanding and cognitive styles on the achievement would be significant at senior secondary school Physics practical. This is likely to have implications in Physics practical teaching.

METHODOLOGY

Research Design

The study adopted a quasi experimental research design with 2×2 non - randomized pretest and posted control group, factorial design.

Sample and Sampling Techniques

The study used multi-stage sampling techniques. Six Local Government Areas were first randomly selected from thirty Local Governments in Osun State, then four public and two private secondary schools were randomly selected from each Local Government using simple random sampling. An arm of Senior Secondary Schools (SS2) was randomly selected from each school and all the students in the class were part of the experiment.

Research Instrument

Two instruments used for this study were Physics Practical Test (PPT) and Cognitive Test in Physics (CTP). Physics Practical Test (PPT) comprised of sections A and B. Section A of Physics Practical Test (PPT) consists of twenty objectives items constructed and developed by the researcher from a test blue print to reflect the level of knowledge, comprehension, application, analysis and synthesis. While Section B consists of two practical questions prepared by two experts in Test and Measurements from West African Examination Council (WAEC). The difficulty and discrimination indices of PPT were determined in order to eliminate too difficult or easy questions. This test was scored manually with each correct option attracting a score of 1 mark for Section A while a wrong option attracted 0 score. The score for Section B of PPT attracts 30 marks. The marking scheme was developed by four experienced Physics teachers (experts) who are examiners of WAEC. The area covered in the marking scheme includes observation, graphical representation, mathematical concept and principles; therefore the maximum score of the whole PPT is 50 marks. The total scores of students for PPT provide a measure of students' achievement in Physics practical. The reliability of Section A of PPT text was obtained using Kuder Richardson 21 and found to be 0.98 while Cronbach coefficient alpha was used for Section B and found to be 0.70.

The Cognitive Test in Physics was constructed by two experts, one of the experts was in test and measurement and the other was a cognitive psychologist. The initial draft of the Cognitive Test in Physics (CTP) consisted of 20 items. The final draft used for the research work is made up of 15 items after validation, with each containing 3 pictures. Two of which can be logically associated together by making necessary inference as related to Physics. This enabled the researcher to categorize the students into analytic or non-analytic. Cronbach coefficient alpha reliability of 0.75 was obtained for CPT. To each of the item, a student scores a maximum of 1 mark in respect of the best option and 0.5 for the second option which is half truth about Physics and the 0 for the last option which is not related to Physics.

EXPERIMENTAL PROCEDURE

The researcher first visited the schools to be used for permission from the school principals after which time for the research work and the training of research assistance used were fixed. The training of the research assistance was done by the researcher at the same time for homogeneity. The Cognitive Test in Physics (CTP) was first administered on students to classify each group into analytical and non-analytical. The two groups were exposed to Physics practical for six weeks using conventional approach. A pre text was administered to determine the

achievement of the students in the two groups before the treatment. The students in the experimental group were exposed to the following concepts before the practical sessions - symbolic concepts in the experiment, understanding of principles and laws that govern the experiments and understanding of concepts of mathematical languages for three weeks. The topics taught were: measurement of acceleration from simple pendulum, investigation of the measurement of elastic constant of a spiral spring, relative density and density of solid by the principle of moment and determination of unknown mass by principle of moments. The whole research exercises lasted for ten weeks.

The students in the control group were taught the same practical topics as those in the experimental group except that they were not engaged in the procedures of concept teaching. At the end of the treatment, the two groups were post tested.

DATA ANALYSIS

t-test and Analysis of Covariance (ANCOVA) were used to establish the effects of cognitive styles and concept understanding on students' achievement. Where there is evidence of significant differences in the interactive effects of the independent variables, Multiple Classification Analysis was used to determine the magnitude of each cognitive styles and concept understanding on students' achievement variable.

RESULTS

Research Question One

What is the main effect of (a) concept understanding (b) cognitive styles on students' Achievement ?

Table 1: Analysis of covariance of practical achievement test according to treatment and cognitive styles.

Source	Sum of squares	df	Mean Squares	F	Significant
Pretest (Covariant)	3.238	1	3.238	490	0.485
Treatment	3726.401	1	219.200	33.148	0.00
Cognitive	2832.201	1	2832.201	428.290	0.00
2-Way Interaction:					
Treatment and Cognitive	2950.208	1	368.776	55.767	0.00
Model	297339.085	28	10619.253	1605.881	0.00
Residual	1401.915	212	6.613		
Total	29874.000	240			

RECOMMENDATIONS

Based on the findings of this study, it was recommended that:

The teachers should make optimum use of concept teaching adequately before embarking on Physics practical.

Teachers should engage students in practical work from SSS1 to enhance their analytical style. Considerable periods should be allotted to emphasize the mathematical concept before the practical class; Enhancement of cognitive style of students should be promoted by allowing them (individually) to participate in setting of physics experiment and making logical conclusion based on their findings.

LIMITATION OF THE STUDY

Being an experimental research, the study could not involve all the students offering Physics in Nigeria. It could not also extend beyond Nigeria to other countries as a result of the experimental nature. Similar study could therefore be carried out in other parts of the world.

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