# EFFECT OF INSTRUCTIONAL ANALOGY AS ADVANCE ORGANIZER ON STUDENTS' PERFORMANCE IN PHYSICS IN SECONDARY SCHOOL IN PORT HARCOURT CITY LOCAL GOVERNMENT AREA.

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## Abstract

*This study investigated the effect of instructional analogy as advance organizer on senior secondary school students' performance in Physics in Port Harcourt-City Local Government Area (PHALGA), Rivers State. The study adopted a non-randomized pre-test posttest control group quasi-experimental design. Eleven thousand nine hundred and twenty-three (11,923) students in 15 public secondary schools in PHALGA formed the population of the study. One hundred and fifty-five (155) physics students in four intact classes selected from two schools constituted the sample for the study. Two research questions and two hypotheses were posed and formulated respectively to guide the study. The instrument used in data collection was titled "Physics Performance Test'. Face and content validity of the instrument were carried out by experts in physics education and measurement and evaluation. Test-retest and Kuder-Richardson-20 methods of reliability were employed. A reliability coefficient of 0.82 and 0.74 respectively were obtained. Item analysis was done to determine the psychometric features of each test item. The research questions were answered using descriptive statistics of mean and the corresponding null hypotheses were tested using Analysis of Covariance and z-test at 0.05 level of significance. Results from the study revealed among others, that the mean score of the experimental group was higher than the mean score of the control group. Therefore, it was recommended that teachers should use instructional analogy advance organizer in teaching energy transfer. Also, teachers should engage students in an active process of learning through the use of analogies to serve as advance organizer to create a linkage between what the students already know and the new concept to be learnt.*

**Keywords***:* Instructional Analogy; Advance Organizer; Energy Transfer; Performance

## Introduction

Energy is an important concept in science because it can be applied very widely to a huge range of phenomena of very different kind across all the sciences. As energy is such an abstract concept, a more 'concrete' model helps students to imagine it and think about it. Because energy is conserved, it behaves rather like fluid. We can picture it been stored in some places and flowing from one place to another. When thinking about a specific process or event, it makes sense to ask where the energy is at the beginning, where it comes from and where it goes and where it ends. This is of course, a model; energy is not really an invisible fluid or indeed stuff of any kind.

At some point in science programmes for students, a teacher will teach students on how to see a process and events from an energy perspective – in terms of energy transfer from one place to another. This is usually first introduced as a qualitative model, describing processes in energy terms without attempting to measure amount. Later it can be developed more quantitatively by introducing equations for measuring the change in the amount of energy stored, transferred and conserved.

It is evident in literature that energy transfer is one of the topics that students have learning difficulties and finds it difficult to grasp (Millar, 2011). This is due to the abstract nature of the concept of energy transfer. Students know that energy is transfer through a medium, but seem not understand how it is transferred and what is making it flow; it is invisible. This makes student susceptible to a lot of unscientific imagination that sometimes lead to alternative conception. Careful uses of constructivist approach such as instructional analogy could enhance and foster students' conceptualization of an abstract topic like heat transfer.

An analogy is a correlation or resemblance. It can be referred to as an explicit, non-literal comparison between two objects, or sets of objects that describe their structural, functional and causal similarities (Nawaf, 2016). According to Tark, *et al.* (2010), analogical reasoning is a cognitive skill that underpins many 21st century competencies. Analogy and analogical models have always been a key part of scientific reasoning even from the 16th century. Great scientist like Galileo Galilei had used analogical reasoning to explain the rotation of the earth about the sun and not otherwise, to his contemporaries. Analogies are mental tools that help students conceptualize the subject matter and create a link between what they know and what to expect. The development of analogy is hinged on the principle that the single and most important factor influencing learners is what they already know. There are types of analogy which are: part to whole, cause to effect, source to product, general to specific, sequence, synonym and antonyms, etc. Analogies are easy to construct and manipulate by the teacher by aligning key features of source and target domains based on clear understanding and purpose. Instructional analogy assists learners to orderly recall, arrange their existing schemas (previous knowledge) and create a picture from what is known to what to expect, thereby facilitating understanding and retention which improves academic performance.

Despite their benefits, instructional analogies can pose challenges related to finding appropriate source domains, the potential for misleading or incomplete comparisons, and individual differences in learners' prior knowledge. Nawaf (2016) aver that analogy are double-edged sword, they can foster understanding but can also lead to misconception if not appropriately used. Careful analogy selection and clear guidance are necessary to mitigate these challenges. Instructional analogies find applications in a wide range of educational settings, primary schools, secondary schools, higher education, science communication, and professional training. They are particularly valuable in teaching complex scientific concepts and abstract theories.

The subsumption learning theory has similar purpose in context with instructional analogy as advance organizer. The theory states the importance of a learner's prior knowledge (schema in their cognitive domain) as a relevant factor that assists them to learn new concept. This process is called meaningful learning and it takes place in their cognitive domain. A schema describes pattern of thinking and behavour. These schemas act as cognitive structures that help us make sense of new information by linking it to existing knowledge. Just like a filing system, schemas allow us to efficiently categorize and understand the vast array of information we encounter daily. In 1970s, psychologist Rumelhart and others made a lot of research to develop the concept of schema into a complete theory. The theory emphasizes that the knowledge and knowledge structure that people already have has a decisive effect on their cognitive activities. These gave credence to the work of Piaget who averred that there are several processes involved in learning as well as the development of schema including Assimilation and Accommodation.

In the context of this study, schema or prior knowledge are the past experiences of the learner that can be recalled and used when they are prepared to learn new information so that the level of comprehension of the new information is enhanced, meaningful and applicable. Ausubel (1968) introduced advance organizers to explain the concept of meaningful verbal learning.

Ausubel believed that advance organizers strategy can provide the needed mental tools that can bridge the gap between what the learner already knows and what he needs to know so that he can learn the task at hand more expeditiously (Okoronka, & Wada, 2014). The focus of Ausubel's work addresses the role and nature of advance organizers and how they might be employed by teachers to help students facilitate the learning and recall of verbal information. This theory therefore postulates that any learner can learn, comprehend and retain new information or material (acquire knowledge) provided that the relevant advance organizers are presented before the lesson that activates learner' s prior knowledge or serve the purpose of providing the needed prior knowledge relevant for acquisition of material content. The concept of advance organizers is to concretize learning and retention by use of learner's schema in their cognitive structure to create a connection between what they already know and have experienced to what they are to expect or experience.

Samuel, Anthony and Zachariah (2013) define an Advance Organizer as a cognitive instructional strategy used to promote learning and retention of new information. An Advance Organizer is information that is presented prior to the learning that can be used by the learner to organize and interpret new incoming information. In explaining meaningful learning, Ausubel introduced the concept of subsumption model as a pedagogic device in which central and highly unifying ideas are stated in terms already familiar to the learner, to which the learner can relate new ideas by subsumption. The concept of Advance Organizer enhances the learning of the students; these can also be called linking agents, as they link the previous knowledge to the newly learnt knowledge. It is designed to indicate the relevant prior knowledge of a learner and it is usually presented at a higher level of abstraction, generality and inconclusiveness than that of the planned lesson. The flexibility of advance organizer makes it easy to appropriately modify them for students with special needs, and that they explicitly inform students what they will be learning thus reducing the possible stress of the unknown which has been shown to negatively impact student achievement (UzZaman, Choudhary & Qamar, 2015).

Advance organizer is beneficial to encourage students to directly participate in their learning and to be self-reflective throughout the lesson. The use of advance organizers is not a teaching method on its own but a teaching strategy needed to help clarify the science concepts the students are trying to attain. Studies have revealed that Advance Organizers favors higher achievement and retention abilities and facilitate acquisition of more scientific concepts (Okoronka & Wada, 2014). Advance Organizer takes different forms such as analogy, cards, maps, descriptions with pictures, flowcharts, story maps, Venn-diagrams and questions, orals and visuals (Ayandat, et al, 2012).). The studies of Umesh (2017) revealed that, the teaching of science by the advance organizer model is better than by the conventional methods of teaching of science. Permanent and meaningful learning is the target of our educational endeavor while understanding and retention are the products of meaningful learning when teaching is effective and meaningful to students.

**Purpose of the Study**

The purpose of this study is to determine the effects of instructional analogy as advances organizer on students' performance in Physics. Specifically, the study intends to:

i. determine if there is any significant difference in the performance of students taught Energy transfer using instructional analogy as advance organizer and those taught using lecture method.
ii. ascertain the difference in the mean score performance of male and female students taught Energy transfer using instructional analogy as advance organizer?

**Research Questions**

i. What is the difference in the mean score performance of students taught Energy transfer using instructional analogy as advance organizer and those taught using lecture method?
ii. What is the difference in the mean score performance of male and female students taught Energy transfer using instructional analogy as advance organizer?

**Hypotheses**

i. There is no significant difference in the mean score performance of students taught energy transfer using instructional analogy advance organizer and those taught using lecture method.
ii. There is no significant difference in the mean score performance of male and female students taught Energy transfer using instructional analogy as advance organize

**Methodology**

The research design adopted for this study was a quasi-experimental design. Precisely, the non-randomized, pretest-posttest control group design. The study was conducted in Port Harcourt City Local Government Area of Rivers State, Nigeria. The area was chosen to enable the researcher to have enough time to supervise the experiment properly; the area is accessible at all time of the year. Also, most schools in the Local Government Area are co-educational hence the researcher used only co-educational schools. The population of the study consist all senior secondary school biology students in Port Harcourt City Local Government Area. Eleven thousand nine hundred and twenty-three (11,923) students formed the population of the study. Two schools were purposively selected from nine co-educational secondary schools in Port Harcourt City Local Government Area of Rivers State, Nigeria. The criteria for the selection include:

i. Schools that had an adequately equipped science laboratory.
ii. Schools having at least two professional physics teachers with at least five years of teaching experience.

Two schools out of nine that met the criteria were used for the study. Four intact classes were randomly selected and used in the two schools since each of the schools had two arms (SS2A & SS2B). In each school, there was an experimental class and one control class. A total of 155 Physics Students from the four intact classes in the two schools form the sample for the study.

The research instrument for data collection was “Physics Performance Test” (PPT). The instrument was composed of 20 questions covering the content area and testing the various level of understanding. The instrument was subjected to face and content validation by experts in Physics education. The instrument was further subjected to item analysis to determine the item difficulty index, discrimination index, effectiveness of distracters to verify the psychometric features of each

test items. A reliability coefficient of 0.82 and 0.74 were established using Test-retest and Kuder-Richardson-20 methods of reliability to ascertain the stability and internal consistency of the instrument respectively. These values were considered good enough to use the instrument.

Two instructional methods were used for the study. Instructional analogy strategy was used in teaching the experimental group, while the lecture method was used in teaching the control group. The pre-test was administered to the intact classes in the selected schools to establish the equivalence of the participants in the study. The teachers in the respective schools were trained for one week on how to follow the various steps in the new model in teaching the students. Before treatment, a pre-test was administered to the students. The experiment lasted for four (4) weeks; an equivalent form of the pre-test was administered by the teachers to the student as post-test. Data collected from the pre-test and post-test were kept separately for analysis. This procedure was followed in both experimental and control classes. The research question was answered using descriptive statistics of mean and the corresponding null hypothesis was tested using inferential statistics of ANCOVA at $p \leq 0.05$ level of significance. Data collected from the pre-test in both groups were subjected to a pre-test analysis to ascertain the equivalence of both groups before treatment. The result showed a significance difference in the pre-test mean scores of both groups. This justifies the use of ANCOVA in testing the hypothesis as to statistically take care of the significant difference in both groups.

**Results**

**Research Question One:** What is the difference in the mean score performance of students taught Energy transfer using instructional analogy as advance organizer and those taught using lecture method?

**Table 1: Mean score of students taught energy transfer using instructional analogy as advance organizer and those taught using lecture method**

| *Groups* | *n* | *Pre-test Mean ($M_1$)* | *Post-test Mean ($M_2$)* | *Mean difference (Within)* |
|---|---|---|---|---|
| Control | 75 | 29.87 | 40.13 | 10.26 |
| Experimental | 80 | 35.63 | 58.77 | 23.14 |
| Mean Difference (Between) | | 5.76 | 18.64 | 12.88 |

Result as shown in Table 1, shows an improvement in the performance of the students taught using instructional analogy as advance organizer. The control group had a mean score of 29.87 on the pre-test and mean score of 40.13 on the post- test with a mean difference (gain) of 10.26. The experimental group had a mean score of 35.63 on the pre-test and a mean score of 58.77on the post-test with a mean difference (gain) of 12.88. This shows that the experimental group had a higher mean difference of 23.14 as against 10.26 of the control group. The table shows a mean difference (between) of 12.88 in favour of the experimental group.

**Research Question Two:** What is the difference in the mean score performance of male and female students taught Energy transfer using instructional analogy as advance organizer?

**Table 2: Mean score of male and female students taught energy transfer using instructional analogy as advance organizer**

| *Groups* | *n* | *Pre-test Mean ($M_1$)* | *Post-test Mean ($M_2$)* | *Mean difference (Within)* |
|---|---|---|---|---|
| Male | 46 | 26.37 | 38.22 | **11.85** |
| Female | 34 | 24.14 | 33.65 | **9.51** |
| Mean Difference (Between) | | **2.23** | **4.57** | **2.34** |

Table 2 shows the score of male and female students Energy transfer using instructional analogy as advance organizer As shown, the female students had a mean score of 24.14on the pre-test and a mean score 33.65on the post-test. The male students had a mean score of 26.37on the pre-test and a mean score 38.22on the post-test. These mean scores indicate that there was an increase in students' performance in both groups. This is because, the female students had a mean gain of 9.51between the pre-test and post-test scores, while the male students had a mean gain of 11.85 between the pre-test and post-test scores. The difference between the mean scores ($M_2$) of the male and female students was 4.57 in favor of the male students. This implies that the instructional analogy as advance organizer helps the male students than the female students in their performance in Energy transfer.

**Hypothesis 1**

$H_{O1}$: There is no significant difference in the mean score performance of students taught energy transfer using instructional analogy advance organizer and those taught using lecture method.

**Table 3: ANCOVA for scores of students taught energy transfer using instructional analogy as advance organizer and those taught using lecture method**

| *Source of Variance* | *Sum of Squares* | *df* | *Mean Square* | *F* | *P-value* | *Decision* |
|---|---|---|---|---|---|---|
| Corrected Model | 25584.182[a] | 2 | 12712.091 | 74.316 | .000 | |
| Intercept | 15726.568 | 1 | 15726.568 | 62.075 | .000 | |
| Pre-test | 25328.088 | 1 | 25328.088 | 147.808 | .000 | |
| method | 8974.847 | 1 | 8974.847 | 5.349 | .000 | Rejected |
| Error | 26031.306 | 152 | 171.842 | | | |
| Total | 359500.000 | 155 | | | | |
| Corrected Total | 51497.717 | 154 | | | | |

Result from Table 3, indicate F (1, 152) = 5,349, $p < 0.05$, based on this the hypothesis was rejected. This implies that there was a significant difference between the mean score of students taught energy transfer using instructional analogy as advance organizer and those taught using lecture method.

**Hypothesis 2**

**$H_{O2}$:** There is no significant difference in the mean score performance of male and female students taught Energy transfer using instructional analogy as advance organizer

**Table 4: z-test Decision on the Male and Female Performance Test of Physics students in Energy Transfer**

| *Groups* | *n* | *M* | *S.D.* | *Df* | *Z-cal* | *Z-crit* | *Decision* |
|---|---|---|---|---|---|---|---|
| Female | 34 | 33.65 | 4.11 | 78 | 4.35 | 1.96 | Rejected |
| Male | 46 | 38.22 | 5.24 | | | | |

Result from table 4 indicates that the null hypothesis that states that there is no significant difference between means scores of male and female taught Energy transfer using instructional analogy as

advance organizer was rejected. This is based on the fact that Z-cal value of 4.35 is greater than Z-crt value of 1.96. Hence, the null hypothesis was rejected.

**Discussion**

The findings revealed that there was an improvement in the performance of the students exposed to instructional analogy as advance organizer than those taught energy transfer using lecture method. The test of hypotheses also showed that the difference in the mean score of students taught energy transfer using instructional analogy as advance organizer and those taught with lecture method was statistically significant at 0.05 level of significance in favor of those taught using instructional analogy as advance organizer. This significant difference in the performance could be due to the fact that instructional analogy as advance organizer engages students' interest through minds-on investigation and encourage students to directly participate in their learning and to be self-reflective throughout the lesson. These results corroborate the findings of Nwankwo & Madu (2014) who carried out a study to investigate the effect of analogy teaching approach on students conceptual in Physics in senior secondary school in Ondo State. The study revealed that the analogy teaching approach was found to be more effective than lecture method. This approach fosters the participation of the students in the classroom and their ability to become active learners, analyze relationship and develop critical thinking propensity.

Also, in a bid for further investigation on the effect of instructional analogy as advance organizer on male and female students. The findings revealed that instructional analogy as advance organizer enhanced students' performance in energy transfer amongst the male student than the female students. The test of a hypothesis also showed that the difference in the performance was statistically significant at 0.05 confidence level. This significant difference in the performance could be attributed to the fact that the male students were more logical to link new information to prior knowledge, as well integrate information and relate classroom experience to everyday experiences. The male students may have been more actively involved in the activities. This could have reflected in their performance. This result is at variance with the findings of Okoronka & Wada (2014) who carried out a study to investigate the Effect of analogy instructional strategy, cognitive style and gender on senior secondary school students' achievement in some physics concept in Mubi Metropolis. The study revealed that interaction effect between students' gender and instructional analogy was not significant on students' performance.

**Conclusion**

Based on the empirical evidences presented, instructional analogy as advance organizer is found to enhance the performance of students in energy transfer than lecture method. Therefore, we may say that with the use of analogies, students can see casual connections on familiar domains so that they can make causal explanations or understanding of the subject.

Also, instructional analogy as advance organizer was revealed in the study to enhances male students' performance in energy transfer than female students.

**Recommendations**

Teachers should engage students in an active process of learning through the use of analogies to serve as advance organizer to create a linkage between what the students already know and the new concept to be learnt.

Analogy instructional strategy should be adopted by science teachers to teach some abstract and difficult concept in science subjects.

Physics curriculum planners should incorporate instructional analogy as advance organizer in instructional model for teaching physics in senior secondary school curriculum.

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