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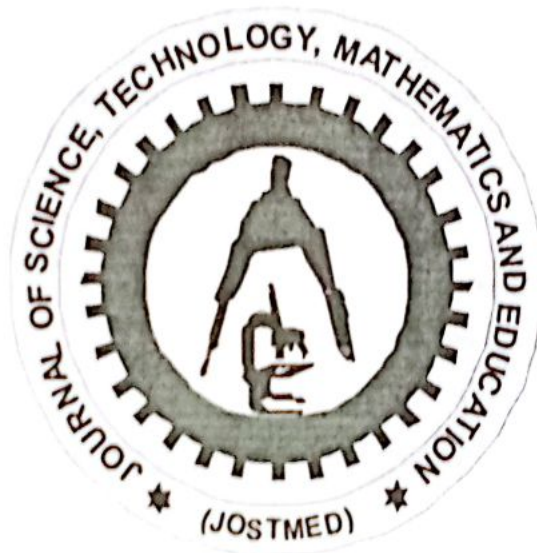
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MISCONCEPTIONS OF ELECTROMAGNETISM HELD BY PHYSICS STUDENTS IN NORTH CENTRAL NIGERIAN COLLEGES OF EDUCATION

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Abstract

Students' conceptions in their subject matter have been found to influence their performance. The purpose of this study was to identify misconceptions of electromagnetic concepts held by male and female students in Nigerian colleges of education. Fourteen colleges of education were purposively selected. The sample involved 718 males and 482 females. A 20-item Electromagnetic Conception Test (ECT), students' questionnaire and the researcher designed Marking Scheme (RMS) were used as the instruments. Mean and t-test were used to analyze the data collected. The finding of the study revealed that 20 identified electromagnetic concepts were held by male and female physics students among college of education in North Central, and there was no significant difference in the number of misconceptions of electromagnetic concepts held by male and female physics students. It was recommended that physics teachers should help students by asking them to give evidence to support their explanations and by revisiting difficult or misunderstood concepts after a few days or weeks, and physics teachers should help students to construct scientifically-accepted concepts regarding that information.

Keywords: Misconceptions, Physics, College of Education, North Central Nigeria

Introduction

Conception can be defined as accumulation of new knowledge that may lead to the formation of new concepts which are never static but dynamic. As students are confronted with new learning situations, they tend to exhibit their previous conceptions which often cause learning interference (Ausubel, 1963). This may give rise to misconception or alternative conception, while misconception means an erroneous knowledge, alternative conception may not be wrong but it is. Whether misconception or alternative conception the classroom teacher is therefore faced with the challenge of teaching to attain an effective conceptual change, since any incorrect conception will hinder effective learning. It is important that a teacher should have the knowledge of students' misconceptions in order to enhance handling the problem of incorrect previous ideas. Based on this knowledge, the teacher will be able to select more effective methods of teaching which could foster better understanding of the concepts. Systematic errors are recurrent wrong responses which are methodically constructed and produced across space and time. Systematic errors are symptomatic of a faulty line of thinking that cause them and it is referred to as a misconception (Green, Piel & Flowers, 2008; Nesher, 1987; Riccomini, 2005). Characteristically, misconceptions are intuitively sensible to learners and can be resilient to instruction designed to correct them (Smith, DiSessa & Roschelle, 1993). Errors are visible in learners' artifacts such as written text or speech. However, misconceptions are often hidden from the undiscerning observer. Sometimes misconceptions can even be hidden in correct answers (Smith, DiSessa & Roschelle, 1993), when correct answers are accidental. Educators need to listen carefully to determine why learners give answers that they give so that they can correctly follow learners' reasoning. Luneta and

Makonye, (2010) assert that most of the errors and misconceptions were due to knowledge gaps and were related to learners' over-dependence on procedural knowledge which had no conceptual basis. On the other hand, learners sometimes had sound conceptual knowledge for which they had not acquired allied procedural knowledge needed to perform in particular questions.

Some reasons have been attributed for students under achievement in schools; these include misunderstood word (Abimbola, 2013), methods of studying, intelligence and gender (Akanbi, 2001; Mattern & Schau, 2002), motivation, attitudes (Craker, 2006; Dieck, 1997), Science teachers and their attitudes (Balogun, 1999), self-adequacy (Normah & Salleh, 2006) and influence of parents (Onah & Ugwu, 2010). Similarly, much research has been conducted on the issue of gender and its relationship to performance in sciences which has generated unresolved controversies. Some studies posited that male students perform better than female students, (Danmole, 1998; Novak & Mosunda, 1991; Oboh, 1998). Others argued that female students perform better than male students (Lawal 1995). Yet, others contend that there is no significant difference between male and female students in achievement (Bello, 1996; Bichi, 2002; Etukudo, 2002; Igboke, 2004; Nussbaum, 2000; Owolabi & Bamdele, 2000; Salman, 2004). If gender difference exists in achievements, there could be gender related differences in misconceptions; hence, this study also looked at the gender and its influence on misconception and the frequencies in order to buttress the existing claims.

Ivowi (1984, 1985, 1986) also observed misconceptions of Physics concepts by students in Nigerian schools. He focused on concepts like motion, conservation principles, fields and quanta. He found many misconceptions and observed that a significant difference existed between their explanations. Muzangwa and Chifamba (2012) asserts that the challenging issue concerning misconceptions is that many people have difficulty in relinquishing misconceptions because the false concepts may be deeply ingrained in the mental map of an individual. Some people do not like to be proved wrong and will continue cling on misconception in the face of evidence to the contrary. This view is consistent with that of Hammer (1996) who thought students' misconceptions:

- (i) are strongly held, stable cognitive structures;
- (ii) differ from expert understanding;
- (iii) affect in a fundamental sense how students understand natural phenomena and scientific explanations; and
- (iv) must be overcome, avoided, or eliminated for students to achieve expert understanding.

A considerable number of researchers in physics education have focused on the identification of students' misconceptions and alternative conceptions of the force and motion concepts. Some of the identified misconceptions were that the force of gravity only acted at the surface of the earth and did not continue to its centre and also that gravity depended on the weight of an object. In recent times, Mankilik (2006) found that remedial students at the University of Jos held many misconceptions of physics concepts. Topics investigated were geometric optics, electricity and magnetism. The following misconceptions were identified: association of water waves to reflection, expressing their physics knowledge in drawing, angles formed as a result of reflection, and association of electric field intensity with force. After the treatment, the remedial students had the following misconceptions: rays are not always perpendicular to wave front; image size is always smaller; electric field intensity is force per unit area.

The annual poor performance of students in Nigeria senior school certificate examination (SSCE) in physics calls for a concerted effort to improve its teaching in secondary schools

(Olorundare, 2014). A major factor which has been observed for such poor performance is lack of understanding of certain physics topics. Similarly, the trend of poor performance in electromagnetic concepts among physics students in colleges of education in Ilorin, Kontagora, Okene and Oro were observed for the years 2005-2009 (Abdulraheem, 2012). Such misunderstandings were found to be largely due to previous incorrect ideas or misconceptions which students exhibit when they are exposed to new knowledge (Ennenbach, 1983; Lewis & Linn, 1994). If these incorrect conceptions or misconceptions are identified, it can be a basis for finding ways of correcting them.

Purpose of the Study

The purpose of this study was to identify misconceptions of electromagnetic concepts held by male and female physics students in Nigerian Colleges of Education.

Research Questions

For the purpose of this study, the following research question was raised:

- (i) What are the misconceptions of electromagnetic concepts held by male and female physics students among colleges of education in North Central, Nigeria?

Null Hypothesis

The following null hypothesis was formulated and tested in this study at $P \leq 0.05$:

Ho: There is no statistically significant difference in the misconceptions of electromagnetic concepts held by male and female physics students among colleges of education in North Central, Nigeria.

Methodology

The research was a descriptive study of the survey type, using questionnaire and electromagnetic concepts test as instruments. The sample for the study was drawn from 17 colleges of education in the North Central zone of Nigeria. Four Federal, eight State and two private Colleges of Education were purposively selected to make up a total of 14 Colleges of Education in the zone. A total of 1200 physics students (718 males and 482 females) using quota sampling technique constituted the sample for the study.

Instrument

Two instruments were used to collect data. They are Students' Questionnaire (SQ) and Electromagnetic Concept Test (ECT). The students' questionnaire contained the bio data of students which were gender, subject combination and name of school. Electromagnetic Concept Test (ECT) consisted of 20 essay electromagnetic concept items which had been subjected to item analysis. The ECT and SQ were validated by three colleges of education physics lecturers and three science educators in a university. ECT was modeled after that described by (Furtak & Ruiz-Primo, 2008). The use of writing activities required students to express their understanding and to think more deeply about why they believed what they did, using open-ended questions to obtain original responses.

Score

Maximum obtained score for each question is 5 points. Any student that has between 0 – 2.5 was regarded as having misconception of the concepts. Furthermore, any student scores ranges from 2.6 – 5.0 has correct conception of the concepts.

Data Collection

After receiving permission from the Head of Department and physics lecturers from the selected Colleges of Education by the researchers, they met with the students and sought their consent and informed them of the study as well as information about the nature and duration of the study. The consent of the parents was also sought through a parent consent form given to each of the students, which was filled and returned to the researchers. The ethical considerations as described by Greene and Hogan (2005, p. 81) were also explained to the Heads of Departments, lecturers in-charge, parents and students and they were adhered to during the research. The students wrote the test shortly before their semester examinations under the supervision of their lecturers which lasted for an hour, and researchers marked the tests according to the marking guide provided by their lecturers. After marking the tests, the researchers analyzed the tests in order to identify students who had similar misconceptions.

Data Analyses

Individual written responses that differed from the scientifically-accepted answer were classified as misconceptions. The number of students who had similar misconceptions was grouped. In order to establish the reliability of ECT, Cronbach alpha coefficient method was used to estimate the internal consistency of the instrument. The reliability coefficient of the test ($r=0.85$) was determined by using the Cronbach's alpha. In this study, mean was used to answer research question and t-test was used to test the null hypothesis.

Physics students hold misconceptions on the electromagnetic concepts posed to them. Misconceptions are a clear indication of poor understanding of concept; hence, some of the pre-knowledge or preconceptions constructed by students were different from scientific concepts that were taught in the classroom.

There are 20 identified electromagnetic concepts held by the College of Education physics students that took part in the study. This finding partially provides an answer to the research question posed in the study. Misconceptions were considered to be an obstacle which hindered learning and which needed to be removed and replaced with the correct concepts. For example, in question 9, students were asked to identify the type of generator that was depicted and to provide a reason for it. The misconceptions that dc motors and generators have slip rings and that motors and generators are the same type of machine, are illustrated by the test script responses to question 9:

A dc generator. There are slip rings used.

dc motor, there is a direct current flowing to the coil and there are two slip ring indicating that this is a dc motor.

Motor generator because of it uses motors to generate it fields and it is accumulated a lot and in magnetism.

It is the motor generator because it has X and Y.

Students may be confused about the differences between motors and generators due to their similar structure and components. It is important for teachers to emphasize that "motors use electrical energy to produce mechanical energy" and that "generators use mechanical energy to produce electrical energy".

Results

Research Question 1

What are the misconceptions of electromagnetic concepts held by male and female physics students among colleges of education in North Central, Nigeria?

A comparison of the mean scores of misconceptions held by male and female students in colleges of education as shown in Table 1 revealed that the mean scores ranges between 0.5–1.4. This implies that both male and female students in colleges of education held misconceptions of electromagnetic concepts.

Table 1: Mean Scores of Misconceptions Held by Physics Students

S/N	Types of Misconception	Mean
1	Electric charges are current electricity present in the system.	0.5
2	Electric field intensity is defined as the magnitude of an electric field at a point in the field.	0.7
3	Electric potential difference can be positive, negative or zero depending on the signs and magnitude q and w .	0.6
4	Gravitational force it state that the force of attraction between two mass is directly proportional to the product of their masses and indirectly to sphere of their distance apart.	0.4
5	Capacitor is a conductor that can be charged by electrostatic induction and examination of charge distribution can be done with electroscope.	0.7
6	Charge distribution over conductor depends on the nature and shape of the surface under consideration	1.2
7	Dielectric material i s the magnetic field at any point in a conductor is greater by a dimensionless factor.	0.7
8	Capacitance of capacitor is a process of determining amount of charge stored by a capacitor.	0.4
9	DC motor, there is a direct current flowing to the coil and there are two slip ring indicating that this is a DC motor.	1.4
10	Alternating current (AC); it has two split rings and moves anticlockwise.	1.2
11	Magnetic flux density can be explained that when the cork cannot sink in water or it own, will make use of a solid that can make the cork to sink.	0.6
12	Transformer is a device that transfers electrical energy from one circuit to another through inductively coupled conductor.	1.0
13	Impedance of an a.c. circuit is the total component of the electric current in the circuit.	0.8
14	Alternating current is the process by which the electric field is reverse periodically, the flow of electric charges reverses also.	0.8
15	Magnetic field is a region or space around a mass where gravitational force can be experienced.	0.5
16	Reactance is opposition of flow of current in the circuit by any electrical component in the circuit.	0.6
17	Resonance frequency is the frequency at which the greatest current appears in the circuit for a given source of voltage amplitude.	0.8
18	Power factor is the ratio of true power to apparent power i. e power factor = true power/apparent power.	0.8
19	Quality factor can be interpreted severally as impedance=magnification times the reactance of the capacitor.	0.8
20	Root mean square value is the square root of the time average of the square of the quantity for a period.	1.2

Ho: There is no statistically significant difference in the misconceptions of electromagnetic concepts held by male and female physics students among colleges of education in North Central, Nigeria.

Table 2 shows that there is no statistically significant difference in the number of conceptions of electromagnetic concepts held by male ($\bar{x} = 11.55$) and female ($\bar{x} = 11.53$) students ($t_{1198} = 0.317$, $p > 0.05$). Looking at the mean, it seems that the average of male students on the ECT is higher than that of female students, but statistically there is no significant difference.

Table 2: t- test analysis of electromagnetic topics held by male and female physics students

Variable	No	Mean	df	t-value	p-value	Remark
Male	718	11.55	1198	0.317	0.15	NS
Female	482	11.53				

$P > 0.05$

Summary of Findings

The findings of this study obtained from the analysis of data are summarized as follows:

- (i) 20 identified electromagnetic concepts were held by male and female students in colleges of education.
- (ii) There was no significant difference in the number of misconceptions of electromagnetic concepts held by male and female physics students.

Discussion

A finding from this study clearly shows that physics students in colleges of education held misconceptions related to 20 identified electromagnetic concepts. Misconception is a response that is clearly in conflict with acceptable scientific conception. This finding provides the answer to the research question in this study. The result is not astounding in view of the fact that studies have shown that students lack scientific understanding of certain physics topics (Hendrickson & Barclay, 2001; Ivowi, 1984, 1985 & 1986; Mankilik, 2006). Such misunderstandings were due to previous incorrect ideas or misconception when they are exposed to new knowledge (Ennenbach, 1983; Lewis & Linn, 1994).

The results of this study indicated that NCE physics students who are about to become physics teachers cannot correctly explain those concepts used in electromagnetism. Misconceptions are very important during the learning processes of individuals. It is well known that it is not easy to eliminate the misconceptions by just employing traditional/convectional method, but by using innovative methods. The misconceptions held by students might have been based on their previous personal experiences before instruction. If wrong ideas were used to explain and interpret new knowledge, misconceptions could arise. The students might be able to explain everyday-life issues with their previous knowledge but not in explaining scientific issues.

Another finding in this study indicates that there was no significant difference in the mean scores of male and female students. This agreed with the finding of Andrew, 2004 that, there was no significant difference between male and female assertiveness in term of their misconceptions. Similarly, studies by Adeoye (2000), and Jimoh and Amoo (2001) indicated

that there was no significant difference in the academic achievement of male and female students in science test. In contrast to the above finding, Omosewo and Akanbi (2013) found out that there was a significant difference in the errors committed by male and female students in physics. The misconceptions held by male and female students may be due to their everyday life experiences or what they think about how and why things are like that.

Conclusion and Recommendations

The outcome of the finding shows that physics students held misconceptions related to concepts of electromagnetism and gender had no significant difference in the number of conceptions of electromagnetic concepts held by students.

Based on the findings from this study, it was recommended that Physics teachers should help students by asking them to give evidence to support their explanations and by revisiting difficult or misunderstood concepts after a few days or weeks, and physics teachers should help students to construct scientifically-accepted concepts regarding that information; that understanding becomes knowledge.

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